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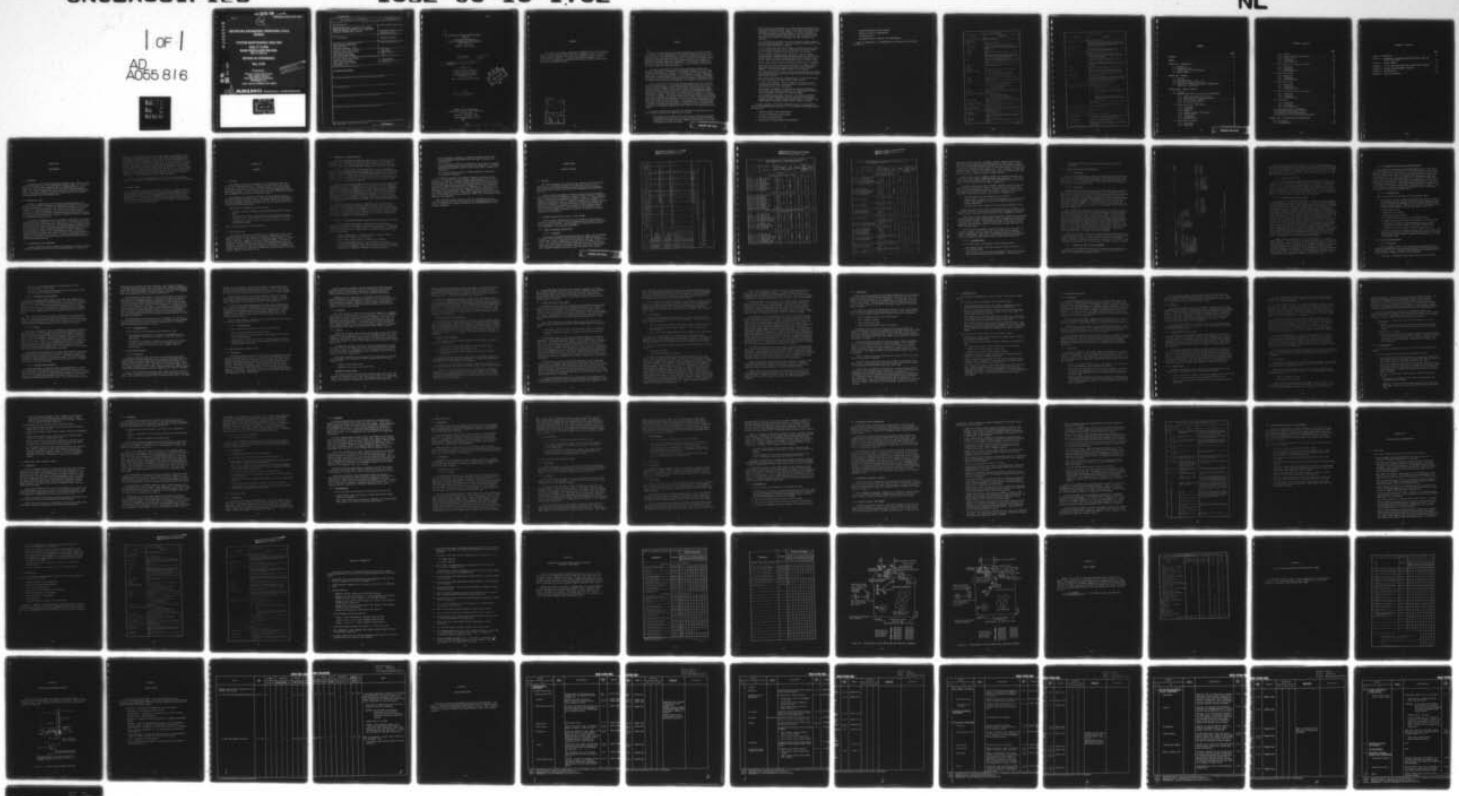

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DESTROYER ENGINEERED OPERATING CYCLE (DDEOC)

SYSTEM MAINTENANCE ANALYSIS

DDG-37 CLASS MAIN PROPULSION BOILERS

SMA 37-108-221

REVIEW OF EXPERIENCE

May 1978

Prepared for

Director, Escort and Cruiser
Ship Logistic Division
Naval Sea Systems Command
Washington, D.C.

under Contract N00024-78-C-4062

ARINC RESEARCH CORPORATION

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by

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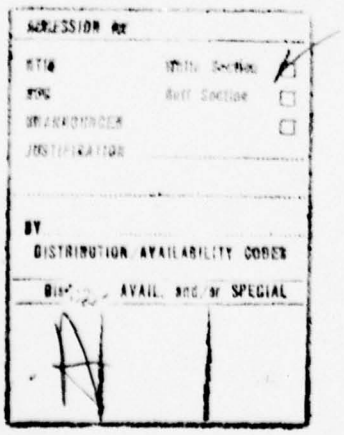
FOREWORD

This report, the Review of Experience, documents the historical maintenance experience for the DDG-37 Class Main Propulsion Boilers, presents an analysis of the problems encountered, and recommends actions to improve system material condition. It has been developed for NAVSEA 934X, the sponsor of the Destroyer Engineered Operating Cycle (DDEOC) Program, under Navy Contract N00024-78-C-4062.



SUMMARY

The goal of the Destroyer Engineered Operating Cycle (DDEOC) Program is to effect an early improvement in the material condition of ships, at an acceptable cost, while maintaining or increasing their operational availability during an extended operating cycle. In support of this goal, System Maintenance Analyses (SMAs) are being conducted for selected systems and subsystems of designated surface combatants. The principal element of an SMA is the Review of Experience (ROE). This report documents the ROE for the DDG-37 Class Main Propulsion Boilers.

The ROE is an analysis of existing and anticipated problems that affect the operational performance or maintenance program of a ship system. The ROE report serves as a vehicle for assessment of the significance and consequence of identified problems. It also presents specific recommendations and a system maintenance policy for preventing or reducing the impact of problem occurrence while improving material condition and maintaining or increasing system availability throughout an extended ship operating cycle.

The Main Propulsion Boilers ROE included an analysis of all available maintenance data sources. The documented maintenance experience of the system was reviewed through analysis of Maintenance Data System (MDS) data, Casualty Reports (CASREPs), and system overhaul records. Initial findings from these sources were correlated with Planned Maintenance System (PMS) requirements, system alterations, and system technical manuals to identify maintenance problems. Ship surveys were conducted and appropriate technical codes were interviewed to validate identified problems, identify undocumented maintenance problems, and determine the status of current and planned actions affecting the Main Propulsion Boilers. All findings were evaluated and appropriate conclusions were developed. Recommendations were then formulated to implement existing and newly defined corrective actions to minimize the occurrence of identified problems and their effect on the extended operating cycle.

The major conclusions resulting from the Review of Experience for the Main Propulsion Boilers are summarized as follows:

- This analysis has shown that most of the major maintenance problems associated with the DDG-37 Class Main Propulsion Boilers have been identified by the Navy technical community and solutions in the form of ShipAlts have been prescribed.

- Major restorative maintenance of the Main Propulsion Boilers may be required at Baseline Overhaul (BOH) in the form of rebricking, tube replacement, and boiler skirt renewal. The material condition of the boiler brickwork, including whether or not the brickwork has been shockhardened (ShipAlt DDG-37-1112D), and the tube waterside conditions will dictate if rebricking and tube replacement are necessary.
- Several outstanding ShipAlts related to feedwater quality improvement should be accomplished. This should allow the extension of the interval between waterside cleaning.
- Boiler lay-ups continue to be a problem, particularly short period wet lay-ups for West Coast ships. Forced hot-air blower heaters are not readily available for fleetwide use in dry lay-ups.
- Several ShipAlts associated with the fuel oil service system, including vented plunger burners and Marotta fuel oil quick closing valves (FOQCVs), should be accomplished at BOH to provide an improved, safer, and more easily maintained fuel oil service system.
- Boiler safety valves should be overhauled at BOH only if necessary.
- During BOH, each boiler should be provided with a Yarway 2500-psi gage glass and two Barton remote boiler water level indicators (RBWLIs). The Nucleonic RBWLIs should not be installed.
- All bottom blow valves should be replaced during BOH and the bottom blow piping replaced in accordance with the monel bottom blow piping ShipAlt DDG-37-1229K.
- Main steam valves should be overhauled only if they exhibit signs of seal ring leakage or steam leakage past the seat.
- A sliding foot movement indicator should be installed on each sliding foot during BOH. An investigation into the use of a non-lubricated foot is also recommended.
- Current PMS requirements, as modified by changes recommended in this report, are adequate to maintain the Main Propulsion Boiler System throughout the Engineered Operating Cycle.
- The recommended maintenance strategy is to continue to operate boilers in strict accordance with the Engineering Operational Sequencing System (EOSS), accomplish PMS checks in an orderly and timely fashion, and perform minor repair actions as needed.

Reliable operation of the Main Propulsion Boilers can be expected during the Engineered Operating Cycle if the following recommended changes are performed:

- Baseline Overhaul (BOH) Requirements
- Intracycle Maintenance Requirements
- Follow-On ROH Requirements
- Reliability and Maintainability Improvements

- Planned Maintenance System Changes
- Industrial Facility Improvements
- IMA Improvements
- Integrated Logistic Support (ILS) Improvements

Table S-1 summarizes all recommendations resulting from this Review of Experience.

Table 5-1. SUMMARY OF ROE RECOMMENDATIONS

Equipment	Recommendation
Baseline Overhaul Requirements	
A. REPAIRS AND OVERHAUL	
Refractory	Renew all castable refractory.
	Rebrick boiler as necessary based on boiler inspection report.
Special Boiler Tools	Conduct an inventory of all special tools to ensure that the on board allowances are in accordance with the manufacturer's boiler technical manuals.
Boiler Skirts	Renew boiler skirts
Safety Valves	Remove and inspect. Repair as necessary based on inspection, CSMP, and POT&I.
Scotblowers	Remove all scotblowers. NDT, inspect, preserve, and reinstall. Those elements which fail NDT or require repairs as determined by inspection, POT&I, and CSMP, should be repaired or replaced. Replace soot blower piping as necessary as determined by NDT, POT&I, and CSMP.
Valves	Overhaul all main boiler stops and main steam valves that exhibit problems such as seal ring leakage or steam leakage past the seat.
	Provide Ship's Force with a suitable valve reseating tool and instruction in its use.
Boiler Sliding Feet	Install a sliding foot movement indicator as shown in Figure 9-2 of NAVSHIPS 0951-LP-031-8010.
B. SHIPALTS	
Refractory	Accomplish ShipAlt DDG-37-1112D, Install Shock Hardened Brickwork.
Feedwater Quality Improvement	Accomplish the following ShipAlts: . DDG-37-1207K, Install Ion Exchanger in Feedwater Line . DDG-37-1056K, Install Morpholine Injection System . DDG-37-1175K, Install Dissolved Oxygen Analyzer
Air Casings	Accomplish ShipAlt DDG-37-0357K, Boiler Outer Casing Replacement, on the FW boiler equipped ships.
Economizers	Accomplish ShipAlt DDG-37-1030K, Economizer Modifications, on the FW boiler equipped ships.
Burners	Accomplish ShipAlt DDG-37-1069K, Vented Plunger Burner Installation. Accomplish the following fuel oil related ShipAlts . DDG-37-0316D, inspect and modify fuel oil burner leads . DDG-37-0361D, modify boiler front . DDG-37-1085K, install Marotta FOXVs
Periscopes	Accomplish ShipAlt DDG-37-1062K, install electronic and intermediate smoke indicator.
Boiler Water Level Indicators (BWLIs)	Accomplish the following ShipAlts: . DDG-37-1058K, install Yarway Gage Glasses . DDG-37-1132K, install Barton remote BWLIs (RBWLIs) Install an additional Barton RWBLI as a back-up or tertiary BWLI.
Bottom Blow System	Accomplish ShipAlt DDG-37-1229K, installation of Monel Bottom blow system. Replace all boiler blow valves.
Superheater Outlet Thermometers	Accomplish ShipAlt DDG-37-1157K, which provides a more reliable means of measuring superheater outlet temperature.
Intracycle Maintenance Requirements	
Main Propulsion Boilers	Accomplish existing PMS requirements as modified by recommendations of this report.
Follow-On ROH Requirements	
Refractory	Renew all castable refractory.
Special Boiler Tools	Conduct an inventory of all special tools to insure that the on-board allowances are in accordance with the manufacturer's boiler technical manuals.
Boiler Skirts	Inspect and repair as necessary.
Safety Valves	Remove and inspect. Repair as necessary based on inspection, CSMP, and POT&I.

(continued)

Table S-1. (continued)

Equipment	Recommendation
Follow-On NOH Requirements (continued)	
Sootblowers	Remove all sootblowers. NDT, inspect, preserve, and reinstall. Those elements which fail NDT or require repairs as determined by inspection, POT&I, and CSMP, should be repaired as replaced. Replace sootblower piping as necessary as determined by NDT, POT&I, and CSMP.
Bottom Blow Valves	Conduct repairs as necessary.
Valves	Overhaul all main boiler stops and main steam valves that exhibit problems such as seal ring leakage or steam leakage past the seat.
Reliability and Maintainability Improvements	
Watersides	Waterjet clean all watersides 1-3 months after NOH. Conduct boiler inspection by certified boiler inspector and based on results of inspection, make a determination as to whether or not the waterside cleaning interval should be extended.
Lay-Ups	Identify the equipment and procedures necessary for implementation of a forced hot-air lay-up capability for the Fleet. Continue the use of hydrazine lay-ups at the depot level. Investigate a combination of hydrazine lay-up and forced hot-air fireside lay-up for ships whose status requires that their boilers be layed up for periods up to 6 months.
B&W Burners	Replace the slotted bushing inserts on the atomizer assemblies with an insert without slots and a rounded end.
Safety Valves	Provide Ship's Force with the new improved safety gags. Change the applicable APLs to reflect the change in gag designs and include instructions for the use of the gag in the boiler technical manual.
Yarway Gage Glasses	Provide Ship's Force with the appropriate special tools required for Yarway gage glass maintenance.
Boiler Sliding Feet	Provide a telltale for the sliding feet that would provide a positive indication of grease flow through the sliding foot. The telltale should be visible from a position near the zerk fitting in order to provide the maintenance man with positive feedback of grease flow. Investigate the use of a non-lubricated sliding foot.
Planned Maintenance System Changes	
Boiler (MIPs F-1/10, F-1/33, and F-1/196)	Change the MRC number F-1 A-2 as follows: . After step 1.b (remove pipe plug from test connection) add the following: WARNING: Do not allow live steam to pressurize the test gauge. This could result in rupturing the gauge and possible personnel injury. . Change step 1.c to read: Prepare a test pressure gauge with a 0 to 600 psi range and 3/8" fittings, by bending the hose to the gauge into a loop and charging the loop with water. Install the test gauge in the test connection. Add the following to the Tools, Parts, Materials, and Test Equipment List of MRC number F-1 R-1: . Light bulb, rough service, NSN 9Q 6240-00-143-3087.
Industrial Facility Improvements	
	None
IMA Improvements	
	None
Integrated Logistic Support (ILS) Improvements	
Yarway Gage Glasses	Increase each ship's allowance to include two complete gage glasses (one per fireroom) to be carried as bulkhead mounted spares.
Bottom Blow Valves	Provide Ship's Force with a minimum of six operating space spares of bottom blow valve, NSN, 9C 4820-01-018-3781.
Boiler Stop Valves	Establish a procedure to insure that changes in the internal dimensions of boiler stop valves are documented and appropriate APL and allowance changes are made.
Boiler Water Level Indicators (BWLIs)	Cancel ShipAlt DDG-37-1070K, install nucleonic BWLIs.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

In support of the Destroyer Engineered Operating Cycle (DDEOC) Program, sponsored by NAVSEA 934X, System Maintenance Analyses (SMAs) are being conducted on selected systems and subsystems of program-designated surface combatants. The principal element of an SMA is the Review of Experience (ROE). This report documents the ROE for the DDG-37 Class Main Propulsion Boilers, which were selected for analysis because they are on the DDG-37 Class Maintenance Critical Equipment List.

1.2 PURPOSE AND SCOPE

The ROE is an analysis of existing and anticipated problems that affect the operational performance or maintenance program of a ship system. The ROE report serves as a vehicle for assessing the significance and consequences of identified problems. The report also recommends specific actions and a system maintenance policy directed toward preventing or reducing the impact of maintenance problem occurrence while improving material condition and maintaining or increasing system availability throughout an extended ship operating cycle.

The analysis documented herein is specifically applicable to the Main Propulsion Boilers installed on the DDG-37 Class. Only those system components that had been installed or were onboard ship as of the fourth quarter of Fiscal Year 1977 were considered. The analysis used all available documented data sources from which system maintenance problems could be identified and studied. These included Maintenance Data System (MDS) data, Casualty Reports (CASREPs), and system overhaul records, in addition to Planned Maintenance System (PMS) requirements data, system alteration documentation, and system technical manuals. Sources of undocumented data employed in this analysis included interviews with Ship's Force and other cognizant technical personnel.

1.3 SYSTEM FUNCTION AND BOUNDARIES

The Main Propulsion Boilers generate the steam used to drive the main propulsion turbines, the ship's service turbo-generators, the main feed

pumps, the forced draft blowers, and all other auxiliary equipments that use steam as a prime mover. The DDG-37 Class ships are each equipped with four boilers that generate main steam, 1200 psi at 950°F measured at the superheater outlet, and auxiliary steam, 1150 psi at 650°F measured at the desuperheater outlet. DDG-37, -38, and -39 are equipped with Foster Wheeler boilers supported by APL 021550074, while DDG-40 through -46 are equipped with Babcock and Wilcox boilers supported by APL 021200163. Each fireroom has two boilers serving a particular engine room, but cross-connects permit operation of any combination of boilers from one boiler cross-connected for economical cruising to all four boilers, with the cross-connects closed (called split plant operation), for full-power operation.

A definition of system boundaries, and a list of system components included in the analysis documented by this report are presented in Appendix A.

1.4 REPORT FORMAT

The remaining chapters of this report describe the analysis approach utilized (Chapter Two), briefly define significant system maintenance problems encountered and discuss potential problem solutions (Chapter Three), and summarize conclusions and recommendations derived from the analysis (Chapter Four). Specific analyses and evaluations supporting the results of this effort are included as appendixes to this report. A selected list of references precedes the appendixes.

CHAPTER TWO

APPROACH

2.1 OVERVIEW

This chapter describes the approach to the performance of the ROE for the Main Propulsion Boilers. Primary data sources were identified in Section 1.2. The data were used to identify, define, and analyze maintenance problems that will significantly affect the Main Propulsion Boilers' maintenance program. A course of action relative to the maintenance program was recommended on the basis of the analysis results.

For purposes of the analysis performed, the Main Propulsion Boiler System was divided into three groups: the Babcock and Wilcox (B&W) boilers and their associated equipment, the Foster Wheeler (FW) boilers and their associated equipment, and other equipment not specifically associated with a particular boiler manufacturer.

Major steps of the analysis were as follows:

- Compiling relevant documented and undocumented maintenance history data
- Analyzing these data to identify and define maintenance problems expected to have significant effect on maintenance of the system
- Recommending a specific course of action for solution of system maintenance problems

Each of these activities is described below.

2.2 DATA COMPILATION

The analysis began with the compilation of comprehensive data on the maintenance history of the system. The data file generated consisted of four key elements: an MDS data bank, a CASREP narrative summary, a system overhaul experience summary, and a system ShipAlt summary. A library of appropriate technical manuals, bulletins, and related documents was also assembled. The MDS data bank was compiled by examination of all MDS data reported for the DDG-37 Class from 1 January 1970 through 30 September 1977. Overhaul information was obtained from authorized Ship Alteration and Repair Packages (SARPs) for the DDG-37 Class.

2.3 MAINTENANCE PROBLEM DEFINITION

Potential maintenance problems associated with the systems and their components were identified by screening data obtained from the above-described sources as well as from ship surveys, interviews with Navy technical personnel, and, when appropriate, NAVSEA special-interest programs.

MDS data constituted the initial and primary source of information screened. The resulting data base includes all part and labor records, as well as narrative material, describing maintenance actions reported against system components. Maintenance actions are represented by Job Control Numbers (JCNs). The purpose of the first step in the screening process was to identify the maintenance actions that had been reported against components of the system under investigation.

Computer-assisted analysis quantified the man-hour and part-expenditure burdens incurred for each component, not only for the selected components individually but also, as appropriate, for each generic class of components. Individual components or component classes which had contributed significantly to the system's maintenance burden were selected for the intensive analysis described below. Components were also selected for analysis if they had generated a significant number of CASREPs or if other sources of information (e.g., ship surveys or overhaul experience) disclosed significant concern regarding maintenance problems or the maintenance programs for the components.

Detailed analysis of the selected components was directed toward defining each maintenance problem in terms of several specific factors: the effect of the problem on the component and system, the interval between occurrences of the problem, the redundancy of the affected component within the system, the criticality of the component to the system, the resources required to perform the maintenance necessary to correct the problem, and the expected component or system downtime.

2.4 ANALYSIS OF COMPONENT MAINTENANCE PROBLEMS AND DEFINITION OF SOLUTIONS

Once the component maintenance problems and their causes were identified, solutions were sought by examining each problem in relation to the extent to which it is recognized and its susceptibility to established types of corrective action. These analysis criteria are expressed in the following questions:

- Is the problem known to the Navy technical community and has a solution been proposed or established?
- Will a design change reduce or eliminate the problem?
- Is the problem PMS-related? Can the problem be reduced or eliminated by changes to PMS? (These changes might include adding or deleting requirements, changing requirement frequency, or developing material condition assessment tests and procedures.)

- Can the problem be reduced or eliminated by improving the Ship's Force, Intermediate Maintenance Activity (IMA), or depot-level capabilities?
- Can the problem be reduced or eliminated by periodically performing restorative maintenance? Should this be accomplished at a Selected Restricted Availability (SRA) by Ship's Force, IMA, or depot-level facilities?
- Is the run-to-failure concept a viable maintenance strategy for the associated equipment?

An affirmative answer to any question resulted in analysis of the effects of the solution and in an estimate, when possible, of the cost to implement the solution. A negative answer prompted the analyst to go to the next question. After all the questions were answered, the alternative near-term and long-term solutions were evaluated and the most acceptable alternatives defined and documented as recommendations. "Near-term" recommended solutions, as used in this report, are those that should be, and are likely to be, accomplished before completion of the initial DDG-37 Class Baseline Overhaul (BOH). "Long-term" recommended solutions are those that are not likely to be accomplished until some or all of the DDG-37 Class BOHs have been completed.

The historical overhaul experience for all installations of each selected component was then correlated with the recommended problem solutions. An evaluation was made to establish the BOH requirements for each selected component.

CHAPTER THREE

ANALYSIS RESULTS

3.1 OVERVIEW

This chapter presents the results of the analysis of the Main Propulsion Boilers. Preliminary analysis of the MDS data resulted in the identification of 29 system components that warranted detailed analysis. The MDS maintenance burden data for these 29 components are summarized in Table 3-1.

A review of part replacement histories identified those replacement parts within the selected components requiring further analysis. Pertinent data for these parts are summarized in Tables 3-2 and 3-3. CASREP analysis supported the analysis of MDS data performed to identify repetitive or significant maintenance actions. Appendix B summarizes the CASREPs reported against the equipments of the Main Propulsion Boilers and indicates the percentage of total system CASREPs attributed to each equipment and the types of failures experienced. Ship surveys and interviews with Navy technical code personnel confirmed the existence of maintenance problems disclosed by the analysis.

3.2 PROBLEMS APPLICABLE TO ALL DDG-37 CLASS BOILERS

Several problems experienced by all of the DDG-37 Class ships are generic in nature and apply to ships equipped with both Babcock and Wilcox and Foster Wheeler boilers. These problems are discussed and solutions are recommended in the following paragraphs.

3.2.1 Boiler Refractory Service Life

3.2.1.1 Discussion

Shore-Based Intermediate Maintenance Activity (SIMA), IMA, and NAVSEC personnel report that most refractory problems are caused by improper installation. This is especially true for burner tiles that require anchor bolts. The incorrect installation of anchor bolts in burner tiles can cause tile buckling that will distort registers, jam air doors, and eventually expose the furnace front plate when the tile cracks. B&W boilers were originally equipped with burner tiles; FW boilers used castable

Table 3-1. COMPONENT BURDENS OF DDG-37 CLASS MAIN PROPULSION BOILERS

APL	Nomenclature	Applicable Ships	Components per Ship	Total Component Population	Total Ship Operating Time (Ship-Years)	Ships Reported	JCNs	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Parts Cost (Dollars)	Average Man-Hours/ Component Operating Year
Babcock and Wilcox (B&W) Boilers and Associated Equipment												
021200163	Main Steam Boiler (B&W)*	7	4	28	41.0	7	2836	52727	31468	84195	463448	513.4
300020102	Burner *	7	24	168	41.0	7	107	771	162	933	38702	1.0
382010002	Periscope	7	4	28	41.0	6	19	204	77	281	2811	1.7
882170237	Pilot Safety Valve*	6	4	24	34.6	7	33	589	128	717	2703	5.2
882170240	Pilot Safety Valve*	1	4	4	6.4	1	10	40	977	1017	5640	39.7
882170239	Drum Safety Valve*	7	8	56	41.0	6	40	345	64	409	6501	1.2
882170241	Superheater Safety Valve*	7	4	28	41.0	5	22	178	47	225	1578	1.4
813020074	Sootblower Head*	7	16	112	41.0	7	67	940	597	1537	2076	2.3
413020075	Sootblower Head*	7	2	14	41.0	6	19	500	36	336	1000	4.1
						Subtotal	3134	55794	33520	89314	523459	
Foster Wheeler (FW) Boilers and Associated Equipment												
021550074	Main Steam Boiler (FW)*	3	4	12	17.8	3	1713	76354	17010	93364	139140	1311.3++
300080084	Burners*	3	16	48	17.8	3	92	1428	168	1596	27828	5.6
382030001	Periscope	3	4	12	17.8	3	12	244	0	244	73	3.4
882170298	Pilot Safety Valve*	3	4	12	17.8	3	24	1782	44	1826	654	25.6
882170247	Drum Safety Valve*	3	8	24	17.8	3	8	0	0	0	11608	0.0
882170248	Superheater Safety Valve*	3	4	12	17.8	1	2	0	0	0	0	0.0
813030028	Sootblower Head*	3	36	108	17.8	3	77	4137	360	4497	1048	7.0
						Subtotal	1928	83945	17582	101527	180351	-
Equipment Not Specifically Associated with a Particular Boiler Manufacturer												
450020083	Jerguson Gage Glass	**	4	-	-	7	73	281	5	286	17701	-
450030034	Yarway Gage Glass	**	4	-	-	4	29	313	481	794	4222	-
882000847	Main Boiler Stop Valve*	5	4	20	30.0	5	52	1281	516	1797	2213	15.0
882000869	Main Boiler Stop Valve*	5	4	20	28.8	4	15	168	118	286	137	2.5
882000523	Bottom Blow Valve	**	-	-	-	1	17	651	94	745	2087	-
882002390	Bottom Blow Valve	**	-	-	-	2	5	286	36	322	0	-
882040761	2.5" IPS 1500 psi Gate Valve	**	-	-	-	10	37	7296	429	7725	482	-
882040806	6.0" IPS 1500 psi Gate Valve	**	-	-	-	5	140	2423	2151	4574	9456	-
882040810	3.0" IPS 600 psi Gate Valve	**	-	-	-	2	13	4136	116	4252	160	-
882041652	2.5" IPS 1500 psi Gate Valve	**	-	-	-	5	55	462	571	1033	10677	-
882041650	6.0" IPS 1500 psi Gate Valve	**	-	-	-	5	81	951	848	1799	2224	-
882040694	3.0" IPS 1500 psi Gate Valve	**	-	-	-	9	68	361	460	821	4527	-
418020002	Tube Punching Gear +	**	-	-	-	10	51	190	75	265	3596	-
						Subtotal	636	18799	5900	24699	56852	
					Grand Totals		5698	158538	57002	215540	760662	
					Total Reported for all System APLs		9132	206949	82930	289879	1097974	
					Percent of Total Accounted for by Selected APLs		62	77	69	74	73	

Notes:

*Critical equipment list item.
**Exact number of installed equipments not available.
+Various APLs for air motors and other tube punching gear were combined under APL 418020002.
++The average man-hours/component operating year for the FW boilers is reduced to 336.0 when the DDG-37 MDS reported data, is removed (67% of total man-hours).

Table 3-2. PREVENTIVE MAINTENANCE AND INSPECTION RELATED PARTS USAGE SUMMARY FOR SELECTED COMPONENTS OF DDG-37 CLASS MAIN PROPULSION BOILERS

Part Identification		Current Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio (×100) of Parts Replaced to Total Population	Number of Ships Reported
NSN	Nomenclature						
Refractory							
Babcock and Wilcox (B&W) Boiler, APL 021200163							
9G 9350-00-153-6804	Plastic Refractory	26.83	1	24	110	458	5
9G 9350-00-153-6823	Plastic Refractory	33.39	-	-	29	-	4
9G 9350-00-152-6811	Refractory	14.04	13	312	36	12	6
9G 9350-00-153-6816	Refractory	12.90	20	480	209	44	7
9Q 5640-00-267-1586	Insulating Block	2.39	15	420	123	29	3
9G 9350-00-229-4185	Insulating Brick	0.83	-	-	720	-	3
9G 9350-00-229-4187	Insulating Brick	0.81	73	2044	129	6	3
9G 9350-00-247-0543	Firebrick	1.21	733	20524	110	0.5	4
9G 9350-00-574-2869	Corner Burner Tile	15.60	11	308	46	15	4
9G 9350-00-574-2870	Segment Burner Tile	4.82	26	728	123	17	4
9G 9350-00-789-1749	Fiberfrax	41.18	8	224	87	39	7
Foster Wheeler (FW) Boiler, APL 021550074							
9G 9350-00-153-6804	Plastic Refractory	26.83	40	480	47	10	3
9G 9350-00-789-1749	Fiberfrax	41.18	8	96	46	48	3
9G 9350-00-153-6811	Refractory	14.04	4	48	11	23	2
9G 9350-00-153-6816	Refractory	12.90	37	444	9	2	2
9G 9350-00-153-6823	Plastic Refractory	33.39	-	-	20	-	2
9G 9350-00-229-4165	Firebrick	1.06	-	-	100	-	1
9G 9350-00-229-4185	Split Brick	0.83	395	4740	200	4	1
9G 9350-00-229-4218	Insulating Brick	1.09	750	9000	50	0.5	1
9G 9350-00-264-1473	Castable	13.32	-	-	12	-	1
9G 9350-00-267-1587	Insulating Block	2.80	-	-	100	-	1
9G 9350-00-558-0457	Castable	10.60	4	48	20	42	2
9Z 9525-00-585-2042	Nichrome Wire	24.85	2	24	6	25	2
Parts Usually Replaced During Waterside and Fireside Maintenance							
B&W Boiler, APL 021200163							
1H 4410-00-830-0314	Hand Hole Plate	37.15	35	980	556	57	7
1H 4410-00-830-0318	Hand Hole Plate	41.00	46	1288	434	34	7
1H 4410-00-830-5632	Hand Hole Plate	45.00	80	2240	814	36	7
9Z 5330-00-306-1128	Hand Hole Plate Gasket	0.48	528	14784	23418	158	7
9Z 5331-00-615-1258	Hand Hole Plate Nut	3.61	119	3332	29	1	3
9Z 5310-00-833-2583	Hand Hole Plate Washer	1.21	161	4508	770	17	6
1H 4410-00-830-0319	Hand Hole Plate Arch Bar	15.50	119	3332	59	2	5
9Z 5330-00-599-5781	Man Hole Gasket	4.68	2	56	604	1079	7
9Z 5310-00-637-3630	Man Hole Cover Nut	0.71	8	224	97	43	3
9Z 5330-00-634-2885	Desuperheater Gasket	2.58	2	56	370	661	7
9Z 5330-00-215-8256	Burner Gasket	7.93	6	168	176	105	7
9Q 5130-00-250-6025	Brush Refill	4.25	28	784	145	18	6
FW Boiler, APL 021550074							
1H 4410-00-772-6594	Hand Hole Plate	31.50	34	408	104	25	3
1H 4410-00-773-8161	Hand Hole Plate	36.00	28	336	74	22	3
9Z 5330-00-803-1921	Hand Hole Plate Gasket	0.46	192	2304	2679	116	3
9Z 5330-00-732-4376	Hand Hole Plate Gasket	0.44	34	408	1038	254	3
9Z 5330-00-599-5781	Man Hole Gasket	4.68	2	24	350	1458	3
9Z 5330-00-513-6038	Desuperheater Gasket	2.23	1	12	59	492	3
9Z 5330-00-289-3752	Desuperheater Gasket	3.12	1	12	62	517	3
9Z 5330-00-836-3848	Feed Line Gasket	1.35	2	24	15	63	3

Table 3-3. CORRECTIVE MAINTENANCE PARTS USAGE SUMMARY FOR SELECTED COMPONENTS OF DDG-37
DDG-37 CLASS MAIN PROPULSION BOILERS

Part Identification		Current Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio (×100) of Parts Replaced to Total Population	Number of Ships Reported
NSN	Nomenclature						
B&W Boiler, APL 021200163 Corrective Maintenance Parts Usage							
XG 9340-00-292-3749	Burner Observation Window	1.00	6	168	138	82	5
2H 4410-00-395-2999	Casing Door Dogs	1.10	-	-	440	-	4
1H 4410-00-395-3000	Casing Door Dogs	0.96	257	7196	1033	14	5
1H 4110-00-841-9906	Desuperheater Assembly	3220.00	1	38	2	7	2
1H 4410-00-898-1813	Economizer Tube	2880.00	21	588	5	0.8	3
Burner, APL 300020102							
9Z 5330-00-892-2570	O-Ring	0.70	1	168	28	17	3
1H 4530-00-075-0380	Auto Shut-Off Valve	1330.00	1	168	4	2	4
9C 4530-00-736-9228	Sprayer Plate	25.58	1	168	80	48	3
1J 5430-00-573-2366	Register Door	33.00	4	1344	11	0.8	3
1H 4530-00-150-6069	Atomizer	508.00	1	168	22	13	2
Periscope, APL 382010002							
1H 4410-00-269-0987	Mirror	8.10	3	84	48	57	3
Pilot Safety Valve, APL 882170237							
9C 4830-00-633-5980	Disk	104.14	1	28	8	29	6
Drum Safety Valve, APL 882170239							
9C 4820-00-036-2051	Spindle	233.50	2	56	7	12	3
9C 4820-00-036-2053	Disk	273.94	2	56	12	21	5
1H 4820-00-169-5316	Safety Valve	3400.00	2	56	1	3	1
Superheater Safety Valve, APL 882170241							
9C 4820-00-036-2047	Disk	220.48	1	28	3	11	3
FW Boiler, APL 021550074 Corrective Maintenance Parts Usage							
2H 4410-00-772-6596	Desuperheater Assy	7650.00	1	12	1	8	1
1H 4410-00-898-7153	Economizer Elements	453.00	22	264	15	6	2
Burner, APL 30008004							
9C 4530-00-069-6381	Atomizer	438.71	1	48	71	148	2
9C 4530-00-177-0514	Diffuser	248.56	1	48	8	17	2
9Z 5330-00-752-8320	O-Ring	0.19	-	-	91	-	2
9Z 5330-00-864-7182	O-Ring	0.18	-	-	69	-	2
9Z 5330-00-929-1764	O-Ring	0.64	-	-	8	-	2
Pilot Safety Valve, APL 882170298							
2H 4820-00-163-5163	Safety Valve	3680.00	1	12	3	25	2
9C 4820-00-862-9416	Spindle	112.20	1	12	2	17	2
Drum Safety Valve, APL 882170247							
2H 4820-00-163-5176	Safety Valve	3800.00	1	24	2	8	1
1H 4410-00-070-9447	Spindle	250.00	1	24	1	4	1
Superheater Safety Valve, APL 882170248							
2H 4820-00-153-8194	Safety Valve	3520.00	1	12	1	8	1

refractory in lieu of tiles. Currently, however, burner tiles are being installed in both kinds of boiler regardless of original design. Burner tiles are normally inspected each time the firebox is entered and repaired as necessary. Normally, these repairs are minor and consist of patching the castable refractory around the burner tiles. This is normally accomplished by Ship's Force. Table 3-2 lists the various types of refractory that have been used by Ship's Force personnel in repair actions.

Major repairs, such as complete renewal of a furnace front wall or a furnace floor, are usually accomplished with IMA assistance. This type of repair work usually requires the skill of an experienced boiler repairman, a skill usually found only at the IMA or depot level.

Cognizant technical personnel at NAVSEC (PHILADIV) reported that castable refractory should have a service life of three to five years while brick refractory (including firebrick, insulating brick, insulating block, and mortar) should last from five to ten years. The major factors that will reduce the effective service life of boiler refractory are:

- Improper warming up and cooling down of the boiler.
- Allowing soot or debris to remain on brickwork while the boiler is fired. This shortens the life of the brickwork by lowering its melting temperature.
- Firing a boiler with clogged or non-functioning expansion joints.

Ship's Force can control all of these factors by strict adherence to procedures outlined in the Engineering Operational Sequencing System (EOSS) and by properly cleaning the boiler furnace at the recommended intervals.

ShipAlt DDG-37-1112D, Shockhardened Brickwork, provides for an improved anchoring system for the brickwork that is more resistant to breakage from boiler movement or shock. This ShipAlt should be accomplished at BOH when the boilers are rebricked. During follow-on ROHs, if a boiler inspector determines that the boilers should be rebricked, the same anchoring procedure should be used.

Boiler refractory should be inspected by Ship's Force each time the furnace is opened. Minor repairs, such as the patching of castable refractory and burner tiles, should be accomplished while the furnace is opened. Additionally, Ship's Force should clean all refractory expansion joints and remove all loose debris each time the furnace is opened.

3.2.1.2 Recommendations

For the long term, the following actions should be taken:

- All castable boiler refractory should be renewed at BOH and at each follow-on ROH.
- ShipAlt DDG-37-1112D should be accomplished at BOH by re-bricking with the shock hardened anchoring procedure. The same type of

anchoring procedure should be used whenever the boilers are rebricked.

3.2.2 Waterside and Fireside Maintenance

3.2.2.1 Background

PMS and the NSTM Chapter 221 require that watersides and firesides be inspected and cleaned when deemed necessary by the engineer officer at an interval not to exceed 2000 operating hours. Ship surveys indicate that many engineer officers schedule boiler waterside and fireside cleaning at approximately 1800 operating hours.

3.2.2.2 Discussion

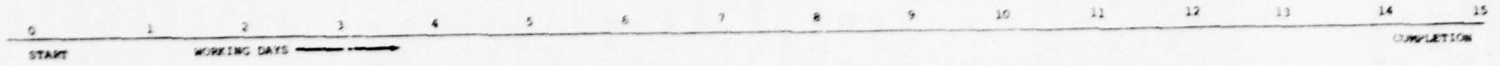
Two methods of waterside cleaning are presently available. The preferred method is to use a high-pressure water jet. This method requires IMA assistance and the use of a portable diesel-engine-driven high-pressure water pump. Normally, three men are required to operate the water jet equipment after the boiler has been disassembled for waterside maintenance. The second method for waterside maintenance is the use of mechanical air-driven tube-cleaning equipment. That method has to be used when IMA assistance is not available. It is not as effective as waterjetting and typically requires about 30 to 50 Ship's Force man-hours over a period of about two working days.

With the advent of high-pressure waterjetting, ship surveys confirm that many engineer officers try to schedule waterside cleaning during an Intermediate Maintenance Activity Availability (IMAV) to take advantage of the improved waterjet method offered by most IMAs. Presently, many ships are scheduling two of the four boilers for waterside waterjetting and firesides cleaning about every four to six calendar months, depending on ship operating tempo. Approximately 550 Ship's Force man-hours per boiler are required to accomplish waterside and fireside cleaning. This figure includes time spent reassembling the boiler and setting the safety valves. It does not include approximately 50 man-hours required by IMA maintenance personnel to operate the waterjet equipment. The total elapsed calendar time is usually about 15 working days.

Table 3-2 lists some of the parts replaced during waterside and fireside maintenance; Figure 3-1 shows the steps, man-hours, and calendar time normally required. Figure 3-1, an estimate of the action necessary to conduct waterside and fireside maintenance on one DDG-37 Class boiler, was formulated from MDS data and interviews with cognizant technical personnel.

3.2.2.3 Mechanical Tube Cleaning Equipment

Ship's Force maintenance personnel reported that the routine use of mechanical tube cleaning or tube punching gear was declining since the advent of the improved waterjetting method.



ACTIONS REQUIRED

Step 1	Step 2	Step 3
Preparation and Disassembly	Waterside Cleaning	Inspection
1. Dry layup of boiler. 2. Allow boiler to cool if necessary. 3. Remove necessary air casing doors for access. 4. Remove all manhole covers and handhole plates. 5. Remove desuperheater and steam drum internals. 6. Open firebox and uptakes. 7. Mechanically clean fireside and uptakes (4-5 days required from cool down to cleaning uptakes).	1. IMA assistance required for water jetting. 2. Allow 24-hour period for drying out of watersides prior to inspection.	1. Formal inspection by a certified boiler inspector or by an engineer officer.

Step 4	Step 5	Step 6
Repairs and Reassembly	Hydrostatic Testing	Set Safety Valves
1. Patch refractory as necessary. 2. Wire brush hand hole seats, request IMA assist to resurface those seats that are steam cut. 3. Reassemble boiler.	1. Hydro desuperheater. 2. Fill boiler and apply hydro pressure to assist in hand hole plate seating. 3. Hydro boiler to prescribed pressure. 4. Dump, flush, fill, and treat boiler.	1. Light off boiler and lift safety valves by steam.

NOTE: Approximately 60% manpower required to clean waterside and fireside on one boiler.

Figure 3-1. TYPICAL DDG-37 CLASS BOILER WATERSIDE AND FIRESIDE CLEANING

As a direct result of the decline in the use of tube punching gear, the ships surveyed reported they suffered a severe maintenance burden cleaning firesides and watersides when a waterjetting facility was not available, as occurred on some major deployments. To avoid this problem, it is recommended that an inventory of the ships' tube punching gear be taken at BOH and all deficiencies corrected.

3.2.2.4 Special Boiler Tools

Ship's Force maintenance personnel indicated that they did not have adequate air driven tools to grind out steam cuts on hand hole and manhole seating surfaces. Each ship's special boiler tools should be inspected before BOH and each follow-on ROH for adequacy and condition, and deficiencies corrected; on completion of BOH and each follow-on ROH, each ship should be equipped with all the allowed special boiler tools as listed in the boiler technical manual for the particular boiler. The portable hydro pump is one such special tool that each ship should have.

3.2.2.5 Feedwater Quality Improvement

The quality of the feedwater entering a boiler has a profound effect on the condition of the boiler's watersides. In this regard, two ShipAlts have been developed by PMS-301 that should improve the quality of feedwater supplied to the boiler. The first, ShipAlt DDG-37-1207K, provides for the installation of an ion exchanger in the feedwater system between the reserve feed tank and the main or auxiliary condensers. This alteration will improve feedwater quality by removing all free metallic and nonmetallic ions, including the chloride, copper, and ferric ions that are harmful to the boiler watersides. The second, ShipAlt DDG-37-1056K, provides for the installation of a morpholine injection system. The morpholine will be injected into the condensate system at the fresh water drain tank and will maintain the condensate at a mildly alkaline pH (8.5 to 9.5). This will reduce the corrosion normally experienced in the condensate and feedwater piping because the alkaline condensate will not dissolve the copper and ferric oxides from the piping. The combined action of these ShipAlts should appreciably improve the quality of feedwater supplied to the boilers. It is recommended that these ShipAlts be accomplished at BOH. Presently, ShipAlt DDG-37-1207K has been accomplished in three of ten DDG-37 Class ships while ShipAlt DDG-37-1056K has been accomplished in seven of ten ships. (See Appendix C for applicable ShipAlt summary).

ShipAlt DDG-37-1175K provides for the installation of a dissolved oxygen analyzer. This ShipAlt has not been installed in any of the DDG-37 Class ships but is being installed in the two ships presently in BOH. No data were available on the ShipAlt and no judgment was made on its impact or effectiveness except for the observation that providing thoroughly deaerated feedwater is fundamental to the maintenance of boiler watersides and any improvements in the ability to monitor boiler feedwater quality should be pursued. For planning purposes, ShipAlt DDG-37-1175K should be scheduled for accomplishment at BOH in all ships of the Class.

3.2.2.6 Extending the Waterside Cleaning Interval

PERA CRUDES boiler inspectors and NAVSECPHILADIV boiler codes report that an extension of the present 1800 to 2000 operating-hour limit between waterside cleanings would be feasible. The exact length of the extension should be based on the results of a boiler inspection approximately one to three months after BOH. There is presently no requirement to open and inspect boilers one to three months after BOH. According to PERA CRUDES boiler inspectors, the period after BOH is considered to be critical since the majority of the debris in the steam piping and boiler will have been eliminated by bottom blows. The boilers should be waterjet cleaned one to three months after BOH and inspected by a certified boiler inspector. The boiler inspector could then recommend extending the limit to some point in the 2000- to 4000-hour operating range.

3.2.2.7 Recommendations

For the long term, the following actions should be taken:

- An inventory should be conducted at BOH and each follow-on ROH of the following special tools to insure that the allowances on board are in accordance with NAVSHIPS 351-0610, Babcock and Wilcox, Main Boiler Technical Manual, Chapter Four, Section 2 and NAVSHIPS 0351--61-5000, Foster Wheeler, 1200 psi Main Boiler, Section S.
  - •• Tube punching gear
  - •• Hand hole seat grinders
  - •• Hydro pump and accessories
- The following ShipAlts should be accomplished at BOH:
  - •• ShipAlt DDG-37-1027K, Install Ion Exchanger in Feedwater Line
  - •• ShipAlt DDG-37-1056K, Install Morpholine Injection System (Presently installed on seven of ten DDG-37 Class ships)
  - •• ShipAlt DDG-37-1175K, Install Dissolved Oxygen Analyzer
- All boilers should be cleaned by waterjet one to three months after BOH and, on the basis of results of a boiler inspection, the waterside operating hours should be extended to some point in the 2000- to 4000-hour range.

3.2.3 Boiler Lay-Up Procedure

3.2.3.1 Discussion

Several different methods can be used to lay-up boilers. No one method is satisfactory for all situations because of the differing operational status of ships. Therefore, three ship-status situations must be considered when discussing boiler lay-up procedures:

- The ship is operational and on short notice to get under way.

- The ship is in an upkeep status and anticipates an in-port period in excess of one month.
- The ship is undergoing an extended restricted availability (RAV) or overhaul at an industrial facility.

3.2.3.2 Operational on Short Notice

Operational ships on short notice to get under way normally use a steam blanket lay-up because it permits them to fire and steam the boiler with only four hours notice. This procedure is satisfactory for limited periods of time, but for periods beyond approximately one month other methods must be used. The steam blanket is unsatisfactory for extended periods because it becomes ineffective in preventing waterside corrosion and could allow contamination of the boiler with silicates from shore steam.

Tests run on shore steam at several locations on the Atlantic Coast have shown that the silicate contained in most shore steam condensate is within the maximum allowable and therefore, East Coast ships can use shore steam for steam blankets. On the West Coast, however, the silicate level is in excess of the allowable and a wet or dry lay-up is required.

3.2.3.3 Upkeep

For ships in an upkeep status or undergoing an extended availability requiring that the boilers be layed-up for periods exceeding one month, the forced-hot-air lay-up method is preferred. This method consists of forcing dehumidified hot air through boiler drums, tubes, and headers as well as through the furnace. While this procedure is effective in preventing waterside corrosion and refractory moisture damage, it has two major shortcomings. First, it is a cumbersome method requiring many man-hours to drain, open, and dry out the boiler and to set up the blowers and dehumidifiers. Second, ships currently do not have the required blowers and dehumidifiers onboard; thus, the forced-hot-air lay-up method can only be practically accomplished by a shipyard.

NAVSECPHILADIV has been tasked to develop less cumbersome procedures for implementing a forced-hot-air lay-up aboard ship and to identify the necessary onboard equipments to be supplied. Candidate equipments and procedures identified under that task were tested. The tested equipment consisted of blower-heaters and though they were acceptable, no standard blower-heater has been designated.

3.2.3.4 Extended RAV or Overhaul

A third procedure, recently developed by NAVSECPHILADIV, is in use for extended boiler lay-up periods by both the Norfolk and Long Beach Naval Shipyards. This method, termed hydrazine lay-up, consists of filling the boiler and backfilling the superheater with feedwater and treating the boiler water with hydrazine through the chemical injection line. The hydrazine scavenges oxygen from the boiler. The results obtained to date

from using this procedure have been excellent. The current procedure is to dump and refill the boiler prior to lighting-off. However, hydrazine is toxic, and the problem involved in disposing of it has prevented widespread use of this lay-up procedure. Because of disposal problems, it is doubted that this procedure will ever be used by Ship's Force.

The hydrazine lay-up procedure is less effective than the forced hot air lay-up in one important respect. Although the hydrazine treatment is very effective in preventing waterside corrosion, the fact that it is a cold water lay-up procedure permits condensation to form on the fireside of the boiler tubes, thus, causing mositure damage to the castable refractory and acid corrosion of the tubes. In our opinion, a combination of the hydrazine waterside lay-up procedure and the forced hot-air procedure for the firesides may provide the best solution for short- and medium-term boiler lay-ups. Since the hydrazine is used up as it absorbs oxygen, it must be continuously monitored and additional treatment provided to replace the depleted hydrazine.

For extended boiler lay-up periods (6 to 12 months), the forced hot-air procedure appears to be the best choice, particularly because extended lay-up periods are usually associated with availabilities or overhauls where the boiler must be open for repairs.

3.2.3.5 Recommendations

For the long term, the following actions should be taken:

- The equipment and procedures necessary for implementation of a forced hot-air boiler lay-up capability in the Fleet should be identified.
- A combination of hydrazine waterside and forced-hot-air fireside lay-ups for operating ships whose status required that their boilers be layed-up for periods up to six months should be investigated.

3.2.4 Air Casing Corrosion

3.2.4.1 Discussion

Cognizant technical codes and Ship's Force maintenance personnel reported that air casing and boiler skirt corrosion, especially where the boiler skirts joined the bilges, was a major maintenance problem. Air casing corrosion results in the deterioration of the casing with a resultant loss in air casing pressure. This loss in air pressure causes the forced draft blowers to run at higher speeds and raises the ambient temperature of the fireroom because of the hot combustion air entering the space.

Ship's Force maintenance personnel report that an indirect result of boiler skirt corrosion is the introduction of bilge water into the air casings. This causes severe rusting of the underside of the boiler, including

headers, hand hole plates, and structural members and contributes significantly to the maintenance burden of Ship's Force. Severe corrosion of the air registers is also caused by bilge water in the air casing, making air registers hard to open and close when lighting-off or securing burners.

Keeping bilges dry is an obvious but extremely difficult solution. The bilges of the DDG-37 Class are rather flat. As a result, it takes only a small amount of bilge water to keep the boiler skirts constantly awash exposing them to the corrosive effects of the bilge water.

The DDG-37 Class ships equipped with FW boilers with aluminum outer air casing panels should have ShipAlt DDG-37-0357K, Boiler Outer Casing Replacement, accomplished. This ShipAlt replaces the presently installed aluminum outer air casing panels with 1/8-inches COR-TEN (a U.S. Steel tradename) or a suitable substitute conforming to MIL-C-7809A. This ShipAlt replaces only the outer boiler air casing panels and does not affect the boiler skirts.

Boiler skirts should be replaced during BOH and inspected and repaired as necessary during each follow-on ROH.

3.2.4.2 Recommendations

For the long term, the following actions should be taken:

- Boiler skirts should be renewed during BOH.
- Air casing skirts should be inspected and repaired as necessary during follow-on ROH.
- ShipAlt DDG-37-0357K, Boiler Outer Casing Replacement, should be accomplished on DDG-37 Class ships equipped with FW boilers with aluminum outer air casings.

3.3 BABCOCK AND WILCOX (B&W) BOILERS

3.3.1 Background

The boilers installed in DDG-40 through -46 were manufactured by B&W and are supported by APL 021200163. Four boilers are installed in each ship with two per fireroom. The boilers are "D" type, two-drum, single-furnace, single-uptake, inclined-bank, natural-circulation units with integral horizontal superheaters. All of the boilers are left-hand boilers: they have the economizer and superheater on the left viewed from the burner front side of the furnace. The installed boilers are practically identical. Each boiler consists of a steam drum connected by tubes to a water drum. A desuperheater located in the water drum supplies low-temperature steam to auxiliaries.

Boiler ancillary equipment includes B&W modified Iowa burners and automatic shut-off valves with a 1000-psi return flow system, Diamond smoke indicators, consolidated safety valves, Diamond sootblowers, Jerguson and Yarway gage glasses, and Barton drum-level indicators.

Combustion air for each boiler is provided by two forced draft blowers manufactured by Hardie-Tynes for DDG-40, -41, and -42, Carrier for DDG-43 and DDG-44, and Westinghouse for DDG-45 and -46, controlled by a General Regulator Automatic Combustion Control System. The boiler is normally controlled from an enclosed operating station (EOS) located on the upper level of each fireroom.

3.3.2 Discussion

MDS data in Table 3-1 shows that the man-hours expended per component operating year for the B&W boilers is 513 man-hours, which is considerably higher than for any of the associated boiler equipment. A review of the MDS narratives indicated that most of the man-hours and parts costs are expended on refractory repairs or on preventive maintenance such as fireside and waterside maintenance. The parts usage for corrective maintenance, shown in Table 3-3, is rather insignificant compared to the preventive maintenance and inspection-related parts usage shown in Table 3-2.

3.3.3 Burners

ShipAlt DDG-37-1069K, Vented Plunger (VP) Atomizer Burner Installation, replaces the existing burners with a straight mechanical VP burner. This ShipAlt has been accomplished on two ships of the DDG-37 Class and is in progress on two others. The remaining ships are scheduled to receive this ShipAlt during BOH. All DDG-37 Class ships will have the ShipAlt installed by FY 1981.

The B&W-boiler-equipped ships were originally equipped with six B&W modified Iowa fuel oil burners per boiler and supported by APL 300020102. As shown in Table C-1 of Appendix C, one of the seven ships has the VP burners installed. The remaining ships are scheduled to receiver the VP burners in FYs 1979 through 1981.

Interviews with Ship's Force personnel and a ship survey of two B&W-boiler-equipped ships disclosed the major problems affecting the B&W burners to be:

- Leakage of the return O-ring
- Leakage of the return swing check valves

Leakage of Return O-Ring

The atomizer body is provided with a bushing insert which, when the atomizer is inserted into the valve body for use, comes into contact and forms a seal with the return O-ring. The bushing insert is a small (1-1/4 inches x 1-3/4 inches) threaded pipe-like device that provides the

connection between the atomizer and the valve body. One end of the insert is threaded and the other end is provided with two 1/8-inch-deep slots that accept a screwdriver, which is used to screw the insert into the atomizer. These screwdriver slots sometimes gouge the return O-ring when the atomizer is inserted, permiting fuel oil to leak out.

Ship's Force maintenance personnel reported that the inserts were rarely, if ever, removed and the slots therefore were not used. A solution to the gouging problem would be to manufacture new inserts without slots and round the ends of the inserts. The rounded insert could be manufactured by an IMA. The elimination of the return O-ring problem would reduce the number of O-rings replaced and reduce the risk of fuel oil leakage. This recommendation applies only to ships without VP burners and is an interim measure designed to reduce the return O-ring leakage problem until the VP atomizers are installed.

Return Swing Check Valve Leakage

The leakage of the return swing check valves is due to improper seating of the valve discs. This problem will be eliminated by the accomplishment of ShipAlt DDG-37-1069K, Vented Plunger (VP) Atomizer Burner Installation, which eliminates the entire return flow system and replaces it with a straight mechanical VP burner. The previously mentioned problem of gouging of the return O-ring will also be corrected since the entire atomizer assembly is replaced by this ShipAlt. This ShipAlt should be accomplished during BOH.

Burner Related ShipAlts

The following fuel oil related ShipAlts are outstanding on some of the DDG-37 Class ships.

- ShipAlt DDG-37-0316D, Inspect/Modify Fuel Oil Burner Leads
- ShipAlt DDG-37-0361D, Modify Boiler Front
- ShipAlt DDG-37-1085K, Install Marotta Fuel Oil Quick Closing Valves (FOQCVs)

ShipAlt DDG-37-0316D verifies that the fuel oil burner leads are in accordance with current applicable drawings. It should be accomplished concurrently with installation of the VP burner.

ShipAlt DDG-47-0316D modifies the boiler front by installing drain holes and cover plates to allow the punching of drip holes during operation.

ShipAlt DDG-37-1085K provides for the installation of an improved remote fuel oil shutdown system by replacing the existing boiler FOQCVs with new ones manufactured by Marotta Scientific Control, Inc., and the addition of quick closing valves in the steam supply lines to the steam driven fuel oil service pumps.

The accomplishment of ShipAlt DDG-37-1069K, VP Burners, and ShipAlt DDG-37-1085K, Improved FOQCVs, are considered more important than the other two applicable fuel oil system ShipAlts since they are safety related. Their accomplishment will result in an improved, safer, and more easily maintained fuel oil system, but all four ShipAlts should be considered for accomplishment during BOH.

3.3.4 Smoke Indicators (Periscopes)

Each B&W boiler was originally equipped with a Diamond three-unit-type smoke indicator, better known as a periscope, supported by APL 382010002. ShipAlt DDG-37-1062K provides for installation of an electronic smoke indicator and an intermediate vision unit designed to provide an indication in the EOS console of smoke density and visible smoke. This ShipAlt provides for complete replacement of the installed Diamond smoke indicator and has been accomplished on three of the seven B&W-boiler-equipped DDG-37 Class ships.

Ship's Force maintenance personnel and MDS data indicated that the primary problems associated with the original Diamond three-unit periscopes were:

- Difficulty involved in bulb replacement while boiler is operating.
- Mirrors cracking, breaking, or becoming discolored and hampering vision

A short-term solution to the bulb-replacement problem is to replace the bulb at a fixed time operating interval with a rough-service type 60-watt bulb. This would reduce the chances of bulb failure during operation. MRC F-1 R-1, which covers the cleaning and inspection of firesides, calls for renewing the periscope light bulb, but does not specify the type of bulb to be used. An addition should be made to the tools, parts, materials, and test equipment called out by the MRC to include a 60-watt, rough-service light bulb, manufactured in accordance with MIL SPEC W-L-101 and provided under NSN 9G-6240-00-143-3087. This NSN is listed on APL 382010002 for the periscope but Ship's Force maintenance personnel report that conventional 60-watt light bulbs are sometimes used instead of the specific bulb required by the APL.

The mirrors will crack and break when subjected to high temperature stack gases. The primary cause of mirror failures was found to be leaks around the sealing glass, which allowed hot stack gases to come into contact with the mirrors. This seal should be inspected very closely during the PMS-required periscope inspection cited previously to insure that no leaks exist. The rather low rate of replacement of the mirrors and the fact that only four ships are still equipped with the old style periscope suggest that no long-term action is necessary.

A long-term solution to both of the previously cited problems is the accomplishment of ShipAlt DDG-37-1062K, which removes the Diamond periscopes and replaces them with an electronic smoke indicator and intermediate vision

unit. MDS data from the ships with the new units indicate that these periscopes are more reliable and have increased visibility. No bulb replacement rates were available for either the old or the new units but Ship's Force operating the new periscopes report that the rate of bulb replacement is considerably lower than for the original Diamond units.

The electronic smoke indicators appear to be reliable. During a visit, one ship was found to be having calibration problems with the indicators in the EOS, but that problem appeared to be more a function of operator and maintenance personnel familiarity than a problem of equipment design. NAVSEC (PHILADIV) personnel also report that the electronic smoke indicators are reliable.

3.3.5 Safety Valves

The B&W-boiler-equipped DDG-37 Class ships are provided with safety valves manufactured by the Consolidated Valve Company. Each boiler is provided with the following:

- One 1.5-inch pilot actuator safety valve supported by APL 882170237
- Two 2.5-inch drum safety valves (numbers 1 and 2) supported by APL 882170239
- One 2.5-inch superheater unloading valve supported by APL 882170241

DDG-46 is an exception: it is equipped with Consolidated pilot actuator safety valves supported by APL 882170240. A review of the APLs for both pilot safety valves revealed no discernible difference in the valves and for the purpose of this ROE both pilots are considered to be identical.

The major maintenance problems associated with the Consolidated safety valves are:

- Bent valve spindles
- Leaks during hydrostatic testing

The bent spindle problem has been addressed by PMS-301, and a new design safety gag has been developed. The new gag has a machined surface and is self-aligning; when it is properly installed and tightened, it should not bend the safety valve spindle. The installation of a gag on the pilot safety is especially critical since it must be gagged while the number 2 drum and number 1 drum safeties are being set. The number 1 drum is also gagged while the number 2 drum is set since it lifts at a lower pressure. The superheater unloading safety valve does not require a gag since it cannot lift without being actuated by the pilot safety. The new design boiler safety valve gags should be provided to all DDG-37 Class ships having Consolidated safety valves. The present APLs for these safety valves, which currently list a size-three mechanical puller, should be changed to reflect an allowance of the new design safety gag. The boiler technical manual does not include detailed instructions on how to install a gag and should be changed to include such instructions.

Leaks during hydrostatic tests are caused by improper seating of the valve disc. The recommended solution is to replace the valve disc in accordance with the applicable technical manual. This procedure can be accomplished by Ship's Force with the valve in place. The new disc should be lapped to the seat bushing as necessary to obtain a flat seating surface.

As shown in Table 3-3, the parts of the safety valves replaced were primarily valve discs. The valve discs on all three safety valves are lapped into their respective seat bushings. The safety valve section of the boiler technical manual indicates that lapping of the disc to the seat bushing should be limited to that necessary to get a perfectly flat surface when a new disc is installed. Extensive lapping to correct leakage problems should be attempted only when a new disc is not available.

The importance of reliable boiler safety valves in 1200-psi boilers is well established; boiler safety valves have been removed and overhauled during ROH almost as a matter of routine. The normal procedure for conducting the 150 percent boiler strength hydrostatic test is to remove the safety valves to prevent damaging them, and even if the valves do not require work they will have to be removed from the boiler during BOH and at each follow-on ROH. PMS-301 and NAVSEC Code 6147B have expressed the opinion that safety valves should be overhauled at BOH. A review of DDG-37 Class SARPs indicates that this is a recurring ROH task. The intracycle maintenance burden for safety valves should be low and consist primarily of minor adjustments by Ship's Force during testing. It can be expected that safety valves will be inspected and tested at about six-month intervals in conjunction with waterside maintenance. Since the intracycle maintenance has been historically low and there is a rigid testing schedule associated with the valves it is concluded that safety valves should function throughout the intracycle with little major maintenance required.

The complete rebuilding of a safety valve to original specifications may result in difficulty in resetting the valve when it is reinstalled on the boiler. Ship personnel report that safety valves overhauled by depot activities usually require more time to reset than is required for resetting the same valve after waterside maintenance. This is probably due to the complete renewal of the internal parts by the repair activity with little regard for how well the valve worked before being overhauled.

Routine overhauls of safety valves do not, therefore, guarantee that they will function better than they did before overhaul. A complete inspection and check of trueness of the spindle and the quality of the seating surfaces will be necessary to insure reliable operation.

Safety valves should, therefore, be removed from the boilers and thoroughly inspected for bent spindles and cut seats at BOH and each follow-on ROH. A complete overhaul of the valve should be accomplished when the results of this inspection, POT&I, and CSMP information so dictate.

3.3.6 Sootblowers

B&W boilers are equipped with ten Diamond sootblowers, six of which are chain-operated rotating sootblowers supported by APLs 81320074 (four sootblowers each with a blowing arc of 360 degree). The remaining four sootblowers are stationary and are not supported by a specific APL since they have no moving parts. The sootblowers use 1200-psi desuperheated steam that is further reduced to 300 psi by a pressure control disc in the sootblower assembly.

No parts were used by the sootblowers and they are not a major maintenance problem and normally provide reliable service. Ship's Force maintenance personnel reported several minor problems related to sootblowers:

- Frozen elements that will not rotate easily
- Bent or warped elements
- Gasket and packing leaks
- Deteriorated sootblower supply steam piping

Sootblower elements that are frozen or do not rotate easily can usually be restored to service by performing the semiannual PMS check, which requires a thorough cleaning and lubricating of the cams, cam followers, drive gears, and external moving parts. Ship's Force maintenance personnel report they can repair most frozen sootblowers if the causes are external to the boiler air casing.

Internal problems are usually a result of bent or warped sootblowers and are usually corrected during fireside maintenance. The clean-and-inspect-firesides PMS action also includes an inspection of sootblower blowing arcs and element fore and aft positions. Ship's Force cannot normally straighten bent or warped sootblower elements because of a lack of equipment. The normal procedure is to replace the element with an onboard spare.

Repair of gasket and packing gland leaks is within Ship's Force capability and is done as required.

The PMS requires non-destructive testing (NDT) of sootblower piping when a ship is overhauled and that testing usually results in the renewal of some deteriorated sootblower supply and drain lines.

Ship's Force is capable of performing all corrective and preventive maintenance except NDT and piping replacement. To assist Ship's Force in maintaining the sootblower heads free of rust and corrosion, it is recommended that all the rotating sootblower assemblies be removed during BOH, sandblast cleaned, subjected to non-destructive testing, preserved, and reinstalled. It is also recommended that NDT be conducted on all sootblower supply piping and drain piping and any sections below specifications be renewed. The follow-on ROH requirements should be the same as for BOH.

3.3.7 Recommendations

The following recommendations pertain to DDG-37 Class ships with B&W Boilers.

For the near term, the following actions should be taken:

- The slotted bushing inserts on the atomizer assemblies should be replaced with an insert without slots and a rounded end.
- MRC F-1 R-1 should be changed to indicate that the periscope bulb should be replaced with a 60-watt, rough service light bulb, provided by NSN 9G 6240-00-143-3087.
- Until ShipAlt DDG-37-1062K is installed, it should be insured that the periscope seals are thoroughly inspected for leaks and replaced if necessary during the periscope inspection PMS check.
- Ship's Force should be provided with the new improved safety valve gags, the safety valve APLs should be changed to reflect the change in the type of gag, and detailed instructions on how to install the gag on a safety valve should be included in the boiler technical manual.

For the long term, the following actions should be taken:

- ShipAlt DDG-37-1069K, Vented Plunger (VP) Atomizer Burner, should be accomplished during BOH.
- The following fuel-oil-related ShipAlts should be accomplished at BOH:
  - ShipAlt DDG-37-0316D, Inspect Modify Fuel Oil Burner Leads
  - ShipAlt DDG-37-0361D, Modify Boiler Front
  - ShipAlt DDG-37-1085K, Install Marotta FOQCVs
- ShipAlt DDG-37-1062K, Install Electronic and Intermediate Smoke Indicator, should be accomplished at BOH.
- Safety valves should be removed and inspected at BOH and at each follow-on ROH. A judgment of necessary repairs should be made on the basis of the results of the inspection.
- All sootblowers should be removed during BOH and at each follow-on ROH. Depot or IMA should clean, NDT, inspect, preserve, and reinstall sootblower. Repairs determined to be necessary by NDT and inspection results should be accomplished. It can be anticipated that NDT will reveal some sootblower piping that will require replacement.

3.4 FOSTER WHEELER BOILERS

3.4.1 Background

The boilers installed in DDG-37, -38, and -39 are FW "D" types, supported by APL 021550074, with two boilers per fireroom. The boilers are single-furnace, single-uptake, inclined-bank, natural circulation types with integral horizontal superheaters and extended-surface economizers. All of the boilers are left-hand boilers. Except for superheater tilt, the boilers are identical. The tilt in the superheater provides for drainage of the elements. Each boiler consists of a main steam drum which is connected by tubes to the water drum. A desuperheater located in the water drum supplies low-temperature steam to auxiliaries.

Boiler ancillary equipments include Todd LVC-4M burners with a 1000-psi return flow system, Wager smoke indicators, Crosby safety valves, Copes-Vulcan sootblowers, Jerguson gage glasses, and Barton drum level indicators.

Combustion air for each boiler is provided by two Hardie-Tynes forced draft blowers controlled by a General Regulator Automatic Combustion Control System. Control of the boilers is normally from an enclosed operating station located on the upper level of each fireroom.

The FW boilers installed in DDG-37 Class ships have encountered several problems related to the size, shape, and location of the economizer headers. These problems are corrected by installation of a redesigned economizer header as outlined in ShipAlt DDG-37-1030K. Conversations with NAVSEC (PHILADIV) confirmed that this ShipAlt is recommended for accomplishment during BOH.

3.4.2 Discussion

As shown in Table 3-1, the average number of man-hours per component operating year required for the maintenance of the FW boiler is over twice that for the B&W boiler. A review of MDS data (see Table 3-1) and a schedule of DDG-37 Class ROH, conversion, and operating time indicated that the higher man-hours per component operating year may have been caused by the following:

- DDG-37 is equipped with FW boilers and accounted for 67 percent of the total man-hours reported against that boiler.
- DDG-37 was the lead ship of the class to be converted. This ship was low on the learning curve for the DDG-37 conversion process and as a result, many MDS actions are attributed to documentation of INSURV items.
- Numerous problems related to heat stress reduction surfaced during the conversion of DDG-37, and various solutions were implemented. Each of these solutions generated a series of MDS actions to document the problem.

All of the above actions generated MDS data that, when reviewed as a whole, suggests a problem with FW boilers. Such is not the case. This ROE found the same basic problems with both FW and B&W boilers with little or no difference in the required maintenance effort.

3.4.3 Burners

The FW-boiler-equipped ships were originally provided with four Todd LVC-4M burners per boiler. Only DDG-39 is still equipped with these burners. DDG-37, currently in BOH, and DDG-38, whose Complex Overhaul (COH) ended in November 1977, have ShipAlt DDG-37-1069K, VP Atomizer Burner Installation, either in progress or completed. DDG-39 is scheduled for BOH in May 1979 and should have this same ShipAlt accomplished. Since the Todd LVC-4M burners either have been or will be replaced on these ships, further discussion of their problems is not warranted.

As discussed in Section 3.3.3, ShipAlt DDG-37-1085K, which provides for the installation of an improved remote fuel oil shutdown, should also be accomplished during BOH.

3.4.4 Smoke Indicators (Periscopes)

Each FW boiler was originally equipped with a Wager six-unit smoke indicator installed in the boiler uptake. The common name for the unit is a periscope and it is supported by APL 382030001. ShipAlt DDG-37-1062K (discussed in Section 3.3.4) provides for the installation of an improved intermediate vision unit and an electronic smoke indicator. The ShipAlt has been accomplished on DDG-37 and is scheduled for accomplishment on DDG-38 and -39.

The specific maintenance problems associated with the original periscope are similar to those discussed in Section 3.3.4, which deals with the difficulty encountered in bulb replacement and broken or discolored mirrors. Until ShipAlt DDG-37-1062K is accomplished, the routine replacement of the periscope bulb during fireside and waterside maintenance with a 60-watt, rough service light bulb should reduce the replacement problem significantly. The periscope seals should also be checked during the fireside inspection PMS action and repaired or replaced as necessary.

3.4.5 Safety Valves

The FW-boiler-equipped DDG-37 Class ships are provided with Crosby safety valves. Each boiler is provided with the following:

- One 1.5-inch pilot actuator safety valve supported by APL 882170298
- Two 2.5-inch drum safety valves supported by APL 882170247
- One 2.5-inch superheater unloading safety valve supported by APL 882170248

The major maintenance problems associated with Crosby safety valves are the same as those discussed in Section 3.3.5 on Consolidated safety valves: bent spindles and leaks.

The Crosby valves appear to be much more reliable in this class than were the Consolidated. A review of the MDS data showed that almost all of the maintenance actions submitted on the valves originated from one ship. The other two ships had very few problems and when they did they rarely required outside assistance. There were, however, five new safety valves purchased during the data period. This could account for the lack of MDS data, since the entire valves were replaced.

As discussed in Section 3.3.5, the bent spindle problem has been addressed by PMS-301 and an improved safety valve gag will minimize the possibility of bending safety valve spindles. The most recent technical manual for the boiler, NAVSHIPS 0351-061-5010, Volume II of II, dated 1 October 1977, describes the original safety valve gags but does not indicate how they are to be installed on a valve. The new gags should be provided to Ship's Force and an addition made to the technical manual explaining their proper use.

According to NSTM Chapter 221, safety valve leakage is considered excessive when a steady plume of steam, three feet or longer in calm air, is emitted from the atmospheric exhaust line. However, when the valves are repaired, the goal is zero leakage, and Ship's Force can normally replace the discs and eliminate leakage. MDS data do not indicate that safety valves have been enough of a maintenance problem to warrant routine overhaul during BOH or follow-on ROH.

The Crosby safety valves should be removed from the boiler and thoroughly inspected and repaired as necessary during BOH and at each follow-on ROH. Complete overhauls without regard to condition are not warranted or recommended.

3.4.6 Sootblowers

FW boilers are equipped with 11 Copes-Vulcan sootblowers, nine of which are chain-operated rotating units supported by APL 813030028, and two are stationary and do not require an APL.

MDS data and interviews with Ship's Force personnel indicated that sootblowers are not a maintenance problem. Two minor problems related to the sootblowers are:

- Improper blowing pressures
- Blower difficult to operate

These problems are addressed in the trouble-shooting chart of the technical manual, NAVSHIPS 0351-061-500, Volume I of II, Section J. The procedures vary depending on whether the original or new style blower

heads are installed. Both types are covered in the technical manual. All corrective maintenance can be accomplished by Ship's Force with IMA assistance. During BOH and at each follow-on ROH, a repair activity, either depot or IMA, must carefully inspect the sootblower heads and measure their thickness with ultrasonic equipment. Any head with less than 50 percent of original thickness must be replaced. The sootblower element should be removed from the boilers, checked, preserved, and reinstalled.

A review of the PMS requirements for sootblowers revealed that a potentially hazardous condition exists during the performance of the requirements of Maintenance Requirement Card (MRC) Code F-1 A-2, Test Soot Blower Operating Pressure. This MRC should be modified as follows:

- After step 1.b, remove pipe plug from test connection, add the following:
  - WARNING: Do not allow line steam to pressurize the test gage. This could result in rupturing the gage and possible personnel injury.
- Change step 1.c to read:
  - To test the pressure in the system, prepare a test pressure gage with 0 to 600 psi range and 3/8-inch fittings. Before connecting the gauge to a test connection, make a loop in the gage hose and charge the loop with water. Install the test gage in the test connection.

3.4.7 Recommendations

The following recommendations pertain to DDG-37 Class Ships with FW boilers.

For the near term, the following actions should be taken:

- Until ShipAlt DDG-37-1062K is installed, it should be insured that the periscope seals are thoroughly inspected for leaks and replaced if necessary during the periscope inspection PMS check.
- Ship's Force should be provided with the new improved safety valve gags, the safety valve APLs should be changed to reflect the change in the type of gag, and detailed instructions on how to properly install the gag on a safety valve should be included in the boiler technical manual.
- MRC F-1 A-2 of MIP F-1/10, PMS Check A-2, should be changed as follows:
  - After step 1.b, remove pipe plug from test connection, the following should be added:

    WARNING: Do not allow live steam to pressurize the test gage. This could result in rupturing the gage and possible personnel injury.

•• Step 1.c should be changed to read: Prepare a test pressure gage with 0 to 600 psi range and 3/8-inch fittings. Make a loop in the gage hose and charge the loop with water. Install the test gage in the test connection.

For the long term, the following actions should be taken:

- ShipAlt DDG-37-1069K, VP Atomizer Burner Installation, should be accomplished on DDG-39 at BOH.
- ShipAlt DDG-37-1085K, Install Marotta FOQCVs, should be accomplished at BOH.
- ShipAlt DDG-37-1062K, Install Electronic and Intermediate Smoke Indicators, should be accomplished at BOH.
- Safety valves should be removed and inspected at BOH and at each follow-on ROH. A judgment of what repairs are necessary should be made on the basis of results of the inspection.
- All sootblowers should be removed during BOH and at each follow-on ROH. Depot or IMA should clean, NDT, inspect, preserve, and reinstall sootblowers. Repairs should be made as determined necessary by NDT and inspection results. It can be anticipated that NDT will reveal a requirement to replace some sootblower piping.

3.5 BOILER WATER LEVEL INDICATORS (BWLIs)

3.5.1 Background

The main propulsion boilers of the DDG-37 Class ships were originally equipped with a Jerguson gage glass supported by APLs 450020083 (for a right-hand gage glass) and 450020084 (for a left-hand gage glass). Both the B&W and FW boilers were each equipped with either a right- or left-hand gage glass. The gage glasses are interchangeable and it is possible to have any combination of left- and right-hand gage glasses installed. The frame assemblies, which are the major parts of these gage glasses, were modified by installing longer studs and spring washers. The new frame assemblies are supported by new APLs, 4500020202 (right hand) and 4500020203 (left hand).

ShipAlt DDG-37-1058K provided for the installation of one direct reading Yarway 2500-psi gage glass in place of the Jerguson gage glass. This ShipAlt has been accomplished on seven of the ten DDG-37 Class ships and is scheduled for accomplishment on the other three in FY 1979.

Yarway gage glasses are supported by APLs 450030015 and 450030034, the latter being a revised version equipped with spring washers.

DDG-37 Class ships were also provided with a remote BWLI (RBWLI) manufactured by Yarway and supported by APLs 384030006 and 384030007.

3.5.2 Discussion

The Yarway 2500-psi gage glass is the boiler gage glass currently being installed on all DDG-37 Class boilers. MDS data and interviews with cognizant IMA and Ship's Force personnel indicate that the major maintenance problems associated with the Yarway gage glasses are:

- Inadequate special repair tools at the Ship's Force maintenance level
- Improper reassembly of the gage glass resulting in leaks and broken glass
- Lack of a complete assembly as an onboard spare

The new boiler technical manuals have sections devoted to gage glass repair which, if properly followed, will reduce reassembly problems. The special tools, however, required for proper maintenance of the gage glass should be provided to Ship's Force.

DDG-37 Class ships do not have an allowance for a bulkhead-mounted spare gage glass. During two ship surveys Ship's Force reported that boiler down time due to failed BWLIs could be substantially reduced if one complete gage glass were available as a bulkhead-mounted spare in each fireroom. The two ships surveyed had spare gage glasses that were installed when a gage glass failed. Each DDG-37 Class ship should be provided with two complete gage glasses, NSN 1HD6680-00-866-6136, as a bulkhead-mounted spare. This would allow the immediate replacement of a faulty gage glass on one of the two boilers per fireroom and allow Ship's Force to repair the faulty gage glass while it is removed from the boiler. The spare gage glass should be bulkhead-mounted, one per fireroom, to facilitate quick replacement.

The Yarway RBWLIs have a long history of problems, including ruptured diaphrams, inaccurate or inoperable secondary electrical indicators, and inconsistencies in calibration. NAVSEA recognized this problem and ShipAlt DDG-37-1132K was developed to replace the existing Yarway RBWLIs with more reliable and dependable indicators and repeaters manufactured by ITT-Barton.

The components of the Barton RBWLI are used in other applications in the Automatic Boiler Control System. These components are reliable and have an established training and logistic support network to support them. ShipAlt DDG-37-1132K is, therefore, recommended for accomplishment during BOH on the ships that currently do not have it.

ShipAlt DDG-37-1070K, Nucleonic BWLI, was developed to provide a third independent means of measuring propulsion boiler steam drum level. This ShipAlt has not yet been accomplished on any ships of the DDG-37 Class, though it is programmed. During the course of this analysis, it was found that Nucleonic RWBLIs have been installed on approximately eight ships (none of which are in the DDG-37 Class). The logistics support and training for maintenance of these RBWLIs is not as comprehensive as that for the

Barton RBWLI. Ship personnel on two DDG-37 Class ships reported that they trusted the Barton RBWLIs and would prefer to have another Barton RWBLI installed as a third system instead of a different RBWLI, such as the Nucleonic RBWLI, which they knew nothing about and were not trained to maintain. Various technical codes reported that the matter of installing Nucleonic RBWLIs was still under consideration. On the basis of the reliability record of the Barton RBWLIs and the existing logistic and training support for the components of the Barton RBWLIs, it is recommended that each DDG-37 Class boiler be equipped with the following:

- One Yarway 2500-psi gage glass
- Two independent Barton RBWLIs

It is also recommended that ShipAlt DDG-37-1070K, which provides for the installation of Nucleonic RBWLIs, be cancelled since the requirement for a third BWLI would be better filled by a second Barton BWLI, which has a proven reliability record.

3.5.3 Recommendations

The following recommendations pertain to BWLIs.

For the near term, the following actions should be taken:

- Ship's Force should be provided with the appropriate special tools required for Yarway gage glass maintenance.
- Each ship's allowance should be increased to include two complete gage glasses (one per fireroom) to be carried as bulkhead mounted spares (NSN 1HD6680-00-866-6136).

For the long term, the following actions should be taken:

- ShipAlt DDG-37-1058K, Install Yarway Gage Glasses, should be accomplished at BOH.
- ShipAlt DDG-37-1132K, Install Barton RBWLIs, should be accomplished at BOH.
- ShipAlt DDG-37-1070K, Nucleonic RBWLIs, should be cancelled.
- An additional Barton RBWLI, similar to the one provided by ShipAlt DDG-37-1132K, should be installed at BOH.

3.6 BOTTOM BLOW SYSTEM

3.6.1 Background

The DDG-37 Class ships are equipped with 1.5-inch IPS carbon steel bottom blow piping with flanged 1.5-inch carbon steel angle and "Y" bottom blow valves. The valves are supported by various APLs and, as shown in Figures A-1 and A-2, several APLs are reported in MDS data as bottom blow valves. Among those reported are Yarway bonnetless valves, Crane seal ring valves, and Manning, Maxwell and Moore, Inc., valves.

3.6.2 Discussion

The principal maintenance problem associated with the bottom blow piping has been corrosion of the exterior of the piping. ShipAlt DDG-37-1229K replaces the carbon steel piping with monel piping. This ShipAlt has been accomplished on two of the DDG-37 Class ships and is scheduled for accomplishment on the other. The bottom blow piping from the header or drum nozzle to the first flange and the piping beyond the first flange should be replaced. It is recommended that this ShipAlt be accomplished during BOH.

IMA valve shop personnel reported during interviews that bottom blow valve repairs require a major portion of their time. MDS records identify "leaking through" as a recurring failure mode of the valves. IMAs can make almost all the normal repairs and tests required on bottom blow valves since they are usually equipped with the appropriate valve grinding tools. The Yarway bonnetless valves, for example, require a special tool to disassemble the valve and a special grinding tool to resurface the seat.

Ship's Force maintenance personnel reported that several spare bottom blow valves, carried as operating space spares, were very useful. These spares consisted of a minimum of six valves (two rearwall header, two sidewall header, one water drum, and one surface blow) that were installed on a particular boiler while the boiler's valves were being repaired by an IMA. During BOH, a minimum of six new bottom blow valves should be provided to Ship's Force to insure that comparable valves can be used when repairs to the installed valves are required.

APL and technical manuals should be changed to reflect the complete replacement of the boiler blow valves at BOH that will result from the accomplishment of ShipAlt DDG-37-1229K, Install Monel Bottom Blow Piping.

Intracycle and follow-on ROH requirements should be limited to bottom blow valve repairs as deemed necessary by material inspection and POT&I results. These repairs are generally accomplished by an IMA. Ship's Force repairs during the cycle will be limited to routine re-packing of the valve and, as necessary, replacement with the spare valves. It is expected that the new valves will require reworking at least yearly.

3.6.3 Recommendations

For the long term, the following actions should be taken at BOH:

- ShipAlt DDG-37-1229K, Installation of Monel Bottom Blow System, should be accomplished.
- Ship's Force should be provided with a minimum of six spare bottom blow valves to be carried as operating space spares.

3.7 MAIN BOILER STOPS

3.7.1 Background

The DDG-37 Class ships are equipped with 6.0-inch IPS 1500-psi angle valves as boiler stops. Each boiler has one such valve on its superheater outlet supported by APL 882000847 or 882000869. Appendix A shows which ships are equipped with each valve.

The Crane Company manufactures the valve supported by APL 882000847 and the Anchor Equipment Company manufactures the one supported by APL 882000869. The valves are similar in design and utilize a seal ring to form a seal between the valve body and the valve bonnet. The valves are provided with a remote control feature that uses an air motor to close the valve. The valve must be opened manually.

NAVSEC and PMS-301 reported that a revised Valve Repair Technical Manual, addressing all aspects of valve repairs, including seal ring installation, will soon be available. Currently, Ship's Force maintenance personnel do not have a valve repair technical manual.

3.7.2 Discussion

The Ship's Force maintenance effort, as shown in Table 3-1, appears to be higher for the Crane valves than the Anchor valves. No reason could be found for this difference. Both valves exhibited similar failure modes, which were primarily:

- Leakage past the seat
- Seal ring leakage

The leakage past the seats has sometimes been attributed to hairline cracks in the stellite seats, which leak under hydrostatic pressure but not under steam pressure. This anomaly is probably accounted for by the difference in temperature between a hydrostatic test at 70°F and a steaming temperature of 900°F. This problem is especially troublesome since some hairline cracks leak while others do not. Those valves that experience steam leakage or excessive hydrostatic leakage past the seat should be repaired. The repairs required are usually limited to either lapping the seat to remove the cracks or replacing the complete seat.

The seal ring leakage problem is aggravated by the need to remove and replace the seal ring to allow access to the valve seating surface. Ship's Force and IMA personnel reported that a major problem with seal rings on main boiler stops was inadequate supply support. This problem is caused by the failure of depots to consistently document modifications to these valves, such as the installation of an oversized seal ring. The depot should label the modified valves with brass tags when an oversized ring has been installed and give the dimensions of the new ring, but this is not always done. Spare seal rings are often provided to Ship's Force for operating space spares, but changes are not always made to the applicable

APLs. As a result, a ship may continue to carry a spare seal ring for the original valve that will not fit the modified valve. A drawing is being developed by NAVSEC that will standardize the internal dimensions of these valves and will show the two standard sizes for oversize seal rings. All changes made to valves and seal rings should be documented and this information provided to Ship's Force along with adequate spare seal rings. The spare seal rings should also be labeled as to size and valves they will fit. The APLs and the shipboard allowance should also be changed to show the new dimensions.

3.7.3 Recommendations

For the long term, the following actions should be taken:

- Those valves that exhibit problems such as seal ring leakage or steam leakage past the seat should be overhauled at BOH and at each follow-on ROH.
- A procedure should be established to insure that changes in the internal dimensions of boiler stop valves are documented and appropriate APL and allowance changes are made.

3.8 MAIN AND AUXILIARY STEAM GATE VALVES

3.8.1 Background

As shown in Table 3-1, six 2.5-inch IPS and larger gate valves were reported as significantly contributing to the Ship's Force man-hour burden. These valves are used in various applications in the main and auxiliary systems. They are all welded-in, seal-ring-type, gate valves.

3.8.2 Discussion

The valves reported in Table 3-1 are all manufacturered by the Crane Company except for APL 882040806, 6.0-inch IPS 1500-psi gate valve, which is manufactured by the Walworth Company.

The APLs for the Crane valves list a standard size seal ring, an oversize number 1, and an oversize number 2. An NSN is assigned to the standard size seal ring while an activity control number (ACN) is assigned to the oversize numbers. The Walworth valve APLs do not list seal rings other than the standard size. The existenance of these ACNs on the APL do not alleviate the seal ring documentation problem described in Section 3.7.2 on the main boiler stop valves. The valves addressed in this section have the same problem and the recommendations of Section 3.7.3 are applicable to these valves also.

The seating surfaces of a gate valve are different than those of a globe valve and, as a result, a different reseating tool is required. Ship's Force maintenance personnel reported that some DDG-37 Class ships have complete valve reseating tool kits but rarely use them. Ship's Force

should be instructed on the proper use of these valve reseating tools during BOH when some of the valves are opened for repair. This would allow ship personnel to learn by using their own valve reseating tools on their own valves as they are installed in the steam system. In addition to learning the proper techniques required for using the valve reseating tool, Ship's Force would also learn the proper technique to be used in the installation of seal rings since the valve would require reassembly after the seating surfaces are reworked.

3.8.3 Recommendations

For the long term the following actions should be taken:

- Those valves that exhibit problems such as seal ring leakage or steam leakage past the seat should be overhauled at BOH.
- A procedure should be established to insure that changes in the internal dimensions of the valves are documented and appropriate APL and allowance changes are made.
- Ship's Force should be provided with a suitable valve reseating tool and instruction in its use during BOH.

3.9 SLIDING FEET

3.9.1 Background

The water drum and sidewall header are supported by saddles at their forward and after ends. The rear saddles are stationary while the front ones rest on sliding feet, free to move as the boiler expands or contacts because of temperature changes. Both B&W and FW boilers use the same basic arrangement for sliding feet.

3.9.2 Discussion

Frozen sliding feet are a serious problem that can cause boiler foundations to warp and excess stresses to be applied to hull strength members. This is especially critical in the after fireroom where severe binding of a boiler sliding foot can cause main shaft misalignment and damage main shaft steady bearings.

Most sliding feet are presently equipped with a zerk fitting mounted on the outside air casing and connected, via copper or steel tubing, to the saddle grease grooves. This permits lubricating the foot each month, as required by PMS, without having to enter the air casing of the boiler.

The only guarantee of satisfactory greasing of the phosphorous bronze chock facing and grooved saddle interface is to have someone observe the lubrication process from inside the air casing. Satisfactory greasing of the sliding foot should force grease out of the sliding joint at some point.

The requirement to have a person in the air casing completely cancels the advantage gained by having a remote zerk fitting. A telltale should be developed leading from the grease grooves back to the outside of the air casing. This could be similar to the present arrangement used to grease the chock facing. The maintenance man would then be able to grease the sliding foot and confirm grease flow without having to enter the air casing.

There is presently no indicator installed to detect or measure sliding foot movement. A simple indicator such as the "Sliding Saddle Movement Indcator", described in Figure 9-2 of NAVSEA 0951-LP-031-8010, Repair and Overhaul Main Boilers 1200 psi Steam Propulsion Plant, should be installed during BOH to indicate sliding foot movement. (An illustration of this indicator is included in Appendix D.) Presently, the determination that a sliding foot is moving or not is based on the following:

- The grease fitting will not accept the grease or high pressure solvent. (This indicates only that the lines or grease grooves are clogged.)
- Visual inspection from the air casing, providing evidence that grease or debris has been pushed by movement of the foot.

Both these rely heavily on judgment and personal experience and often a steam drum or sidewall header is jacked up to repair a sliding foot when no positive determination had been made that there was in fact no movement.

A long-term solution to the problem would be the elimination of the cause, which is either the lack of lubrication or the use of an improper type of lubrication. Modern materials that do not require grease or maintenance are being used in similar civilian applications and may be feasible for use on sliding feet. It is recommended that an investigation into the use of a non-lubricated surface, such as modern plastics, be conducted. If feasible, a ShipAlt should be developed to install a non-lubricated surface in the chock faces of boiler sliding feet.

3.9.3 Recommendations

For the near term, the following actions should be taken:

- A telltale for the boiler sliding feed should be provided that would give an indication of positive grease flow through the sliding feet. The telltale should be visible from the zerk fitting in order to provide the maintenance man positive feedback.

For the long term, the following actions should be taken:

- The use of a non-lubricated sliding foot should be investigated.
- A sliding foot movement indicator should be installed during BOH.

3.10 SUPERHEATER OUTLET THERMOMETERS

FW and B&W boilers were originally equipped with a direct reading thermometer and a remote distant reading thermometer on the superheater outlet of each boiler. This installation was considered unreliable because of calibration problems. Some of the thermometers were replaced with non-standard items.

ShipAlt DDG-37-1057K was developed to provide a more reliable and standard means of measuring boiler superheater outlet temperature. This ShipAlt provides for the removal of both the direct and distant reading thermometers and replacing them with a distant and remote temperature indicating system that uses thermocouples as sensors. Indicators are provided for superheater outlet temperature readout locally, in the EOS, and in the corresponding engineroom.

A ship survey of a DDG-37 Class ship that has had this ShipAlt accomplished revealed that Ship's Force was unable to calibrate the indicators in the EOS due to the lack of a comparator. An inspection of the sensing elements for the temperature indicating system showed that the direct reading thermometers had been removed and that the thermocouples were installed as required by the ShipAlt. The Ship's Force doubted the accuracy of both of the installed temperature indicating systems. It is recommended that ShipAlt DDG-37-1057K be accomplished, but that the direct thermometer be retained. This would provide one local and two distant reading temperature indicators and would be more reliable than using electrical indicators only. The ShipAlt should be accomplished during BOH before the 150 percent strength test on the boiler since this ShipAlt also requires a 150 percent hydrostatic test.

3.11 RECOMMENDED MAINTENANCE STRATEGY

Most routine boiler maintenance, both corrective and preventive, can be accomplished by Ship's Force with IMA assistance, if required. Castrophic boiler failures caused by flarebacks, tube ruptures, low water casualties, and other unpredictable causes will sometimes require a depot level repair effort to correct.

The recommended maintenance strategy is to continue to operate boilers in strict accordance with EOSS, accomplish PMS checks in an orderly and timely fashion, and perform minor repair actions as they are needed.

3.12 BASELINE OVERHAUL REQUIREMENTS

The Baseline Overhaul concept of the DDEOC Program is to provide the maintenance necessary to restore a system to a condition in which, with a well engineered and executed maintenance program, it can be expected to perform satisfactorily over an extended operating cycle. In keeping with

this policy, specific Baseline Overhaul requirements for the Main Propulsion Boilers are as follows:

- ShipAlt DDG-37-1112D, Shock Hardened Brickwork, should be accomplished. It provides for an improved anchoring system for the brickwork that is more resistant to breakage from boiler movement or shock. The castable refactory would have to be renewed in the accomplishment of this ShipAlt.
- ShipAlt DDG-37-1207K, Feedwater Ion Exchanger, should be accomplished. It will improve feedwater quality by reducing the amount of ions in the feedwater that are harmful to boiler waterside.
- ShipAlt DDG-37-1056K, Morpholine Injection System, should be accomplished. It will reduce feedwater and condensate piping corrosion and improve boiler feedwater quality.
- ShipAlt DDG-37-1175K, Dissolved Oxygen Analyzer, should be accomplished, to provide an accurate means of monitoring deaerated feedwater going to the boiler.
- Special boiler tools required for maintenance should be inventoried and on-board allowance adjusted to agreed with the boiler manufacturers' technical manuals.
- Boiler air casings skirts should be renewed.
- ShipAlt DDG-37-0357K, Boiler Outer Casing Replacement, should be accomplished on DDG-37 Class ships equipped with FW boilers with aluminum outer air casings.
- ShipAlt DDG-37-1030K, Economizer Modification, should be accomplished to correct several long-standing problems encountered with FW boiler economizers.
- ShipAlt DDG-37-1069K, VP Atomizer Burners, should be accomplished. It provides for the removal of the presently installed 1000-psi return flow system and the installation of a straight mechanical burner with a comparable turn-down ratio.
- ShipAlt DDG-37-0361F, Modify Boiler Front, should be accomplished to the boiler front by installing drain holes and cover plates to allow the punching of drip holes during operation.
- ShipAlt DDG-37-1085K, Install Marotta FOQCVs, should be accomplished to provide for the installation of improved FOQCVs in the boiler fuel oil supply line and a quick closing valve in the supply steam line to each fuel oil service pump.
- ShipAlt DDG-37-1062K, Improved Smoke Indicators, should be accomplished. It provides for removal of the present periscope and installation of an improved periscope design. This ShipAlt also provides for the installation of an electronic smoke indicator with a visible indicator in the EOS.
- All safety valves should be removed from the boilers and completely inspected. The valves should be overhauled or replaced as shown to be necessary by inspection, POT&I, and CSMP.

- NDT of sootblower heads and piping should be conducted and parts replaced as necessary.
- ShipAlt DDG-37-1058K, Yarway Gage Glasses, should be accomplished. It provides for the removal of the installed Jerguson gage glasses and replaces them with more reliable Yarway gage glasses.
- ShipAlt DDG-37-1229K, Monel Bottom Blow Piping, should be accomplished. It replaces existing carbon steel piping with Monel piping. The sections of bottom blow piping from the header or drum nozzle to the first flange should also be tested and replaced if necessary.
- All bottom blow valves should be replaced with valves that adequately meet shipboard requirements. Ship's Force should be provided with a minimum of six spare valves.
- Only those main boiler stops that exhibit problems such as seal ring leakage or leakage past the seat should be overhauled. This decision should be based on visual inspection of the valve, POT&I, CSMP, and interviews with Ship's Force maintenance personnel to determine if the valve has a history of leakage during hydrostatic tests and operations.
- Ship's Force should be provided with valve reseating tools and practical instructions in their use on valves installed in the main steam system.
- A sliding foot movement indicator should be installed.
- ShipAlt DDG-37-1057K, More Reliable Method for Superheater Outlet Temperature Measuring, should be modified to retain the installed direct reading thermometer; the remainder of the ShipAlt should be accomplished. This would provide three methods of measuring superheater outlet temperature and it would not be necessary to rely completely on electrical indicators as proposed in the original ShipAlt.

Some of the recommendations resulting from this analysis differ from recommendations made in previous DDEOC documents. Table 3-4 lists the recommendations of the DDG-37 Class SARP Planning Document of February 1978 that should be changed as a result of this analysis. Only the items that require changes, additions, or deletions are included.

The items in Table 3-4 are arranged by Ship Work List Item Number SWLIN to facilitate changes to the Planning SARP. Existing items to be changed are listed by number (i.e., item 1.1.1) and additions are distinguished by the header "(add)" prior to the new item number [i.e., (add) 1.5.2, 2.5.2, 3.5.2, and 4.5.2]. The statements under the description heading are written as they should appear after correction or addition.

The rationale for change given for each change or addition is based on findings of the ROE analysis, results of interviews with technical codes not included in the ROE, or engineering judgment. If the rationale is not included in this ROE, its origin is noted.

Table 3-4. CHANGES TO THE DDG-37 CLASS SARP PLANNING DOCUMENT OF FEBRUARY 1978

SWLIN	Item No.	Description	Rationale For Change
221A01*	1.1.1	Prepare boiler for and conduct 150% strength test in accordance with NSTM Chapter 221.	Paragraph 221-2.339 Inspection and Test for Strength at 5-year period, of NAVSEA 0901-LP-221-0000, NSTM Chapter 221, Boilers, requires a 150% strength test at least every 5 years (not addressed in ROE).
	1.1.2 and 1.1.3	(Change present item 1.1.1 to 1.1.2 and item 1.1.2 to 1.1.3.)	Items concerning 125% hydrostatic test are still valid and could be accomplished immediately following the 150% test (not addressed in ROE).
221A01*	(add) 1.5.2, 2.5.2 3.5.2, and 4.5.2	Rebrick boilers as necessary based on boiler inspection report.	Accomplish only if ShipAlt DDG-37-1112D (see item 1.5.1, 2.5.1, 3.5.1, or 4.5.1) has been accomplished and re-bricking is deemed necessary by a boiler inspection. The normal service life of brickwork should be 5-10 years.
221A01*	(add) 1.5.3, 2.5.3, 3.5.3, and 4.5.3	Renew all castable refractory.	Service life of castable refractory is 3-5 years.
221A01*	(add) 1.6.3, 2.6.3, 3.6.3, and 4.6.3	Renew boiler skirts.	Boiler skirt leaks contribute significantly to Ship's Force maintenance burden.
221A01*	(add) 1.6.4, 2.6.4, 3.6.4, and 4.6.4	Replace aluminum outer air casings on Foster Wheeler Boilers in accordance with ShipAlt DDG-37-0357K.	The Foster Wheeler boiler equipped ships (DDG-37, 38, and 39) were built with aluminum air casings which have proven to be a maintenance problem.
221A01*	1.7.1, 2.7.1, 3.7.1, and 4.7.1	Remove all sootblowers. NDT, inspect, preserve, and reinstall. Those elements which fail NDT or require repairs as determined by inspection, POT&I, and CSMP, should be repaired or replaced.	Routine overhaul of all sootblowers is not warranted. Only those that are inoperative or fail NDT should be repaired or replaced.
221A01*	1.7.2, 2.7.2, 3.7.2, and 4.7.2	Replace soot blower piping as necessary as determined by NDT, POT&I, and CSMP.	Complete replacement of sootblower piping without regard to condition is unwarranted (engineering judgment).
221A01*	5.1	Accomplish ShipAlt DDG-37-1069K, Install vented plunger burner.	The accomplishment of this ShipAlt will result in a safer, more reliable, and easier to maintain fuel oil system.
	(add)	Overhaul all burners, registers, and burner barrels in accordance with TRS 0221-086-___.	DDG-37, 38, and 39 are equipped with 16 burners per ship while DDG-40 thru 46 are equipped with 24 burners per ship. Engineering judgment indicates that the ships that are presently equipped with VP burners will require some minor repairs to the burners during BOH.
22A01*	6.1	Remove and inspect all safety valves. Repair as necessary based on inspection, CSMP, and POT&I.	Safety valves have to be removed from the boiler for the 150% hydro test. Whie they are removed, they should be repaired as necessary. Paragraph 221-3.100 of NAVSEA 0901-LP-221-0000, NSTM Chapter 221, Boilers, states, "In general, safety valves shall be untouched as long as their operation is satisfactory, because disturbing or altering internal parts often results in valve giving unsatisfactory service."
255A10A	1.2.1	Accomplish the following ShipAlts: . DDG-37-1027K, install ion exchanger in feed line . DDG-37-1056, install morpholine injection system . DDG-37-1157K, install dissolved oxygen analyzer	An extension of the waterside cleaning interval should be possible after the accomplishment of these ShipAlts. The watersides should be waterjet cleaned 1-3 months after BOH and a determination made by a certified boiler inspector as to whether or not the waterside cleaning interval should be extended.
261A01A	3.	Accomplish the following fuel oil related ShipAlts: . DDG-37-0316D, inspect and modify fuel oil burner leads. . DDG-37-1085K, install Marotta FOQCVs	The accomplishment of these ShipAlts will result in a safer, more reliable, and easier to maintain, fuel oil system.
		Fuel Oil Quick Closing Valve (no further changes)	Accomplish only if ShipAlt DDG-37-0316D has been accomplished.

*Indicates a particular SWLIN without a revision

3.13 INTRACYLE AND FOLLOW-ON ROH REQUIREMENTS

Ship's Force maintenance personnel, assisted as necessary by an IMA, are capable of accomplishing most of the routine boiler maintenance during the intracycle. Therefore, the only maintenance requirements should be the existing PMS actions as modified by recommendations of this report and minor corrective maintenance, with the support of an IMA as necessary. Castrophic boiler failures are unpredictable; they usually require depot assistance to correct.

The follow-on ROH requirements for the DDG-37 Class Main Propulsion Boilers are as follows:

- All boiler castable refractory should be renewed.
- Boiler brickwork should be inspected and necessary repairs made. Boilers should be rebricked only after a determination of need has been made for each individual boiler.
- Tube punching gears should be inventoried and any deficiencies corrected.
- Boiler skirts should be inspected and sections that are deteriorated renewed.
- All safety valves should be removed from the boilers and completely inspected. Valves should be overhauled or replaced as found to be necessary by the inspection, POT&I, or CSMP.
- NDT of sootblower heads and piping should be conducted and parts replaced as necessary on the basis of NDT results.
- Repairs to bottom blow valves should be conducted as found to be necessary by Pre-Overhaul Test and Inspection (POT&I) and CSMP.
- All main boiler stops and other main steam valves that exhibit problems such as seal ring leakage or steam leakage past the seat should be overhauled.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

This Review of Experience led to the following conclusions:

- Boiler castable refractory should have a service life of 3 to 5 years while brickwork should last 5 to 10 years.
- With the increased use of waterjet cleaning of boiler watersides, there has been a tendency for Ship's Force maintenance personnel to neglect the material condition of the mechanical tube cleaning equipment. This situation becomes critical when a waterjet facility is not available and Ship's Force maintenance personnel must use the mechanical equipment.
- Watersides are normally cleaned about every six months on at least two of the four boilers. This normally requires approximately 600 man-hours per boiler, spread over a period of 10 to 15 working days.
- After the accomplishment of the various feedwater quality improvement ShipAlts, the waterside cleaning interval could be extended to some point between 2000 and 4000 operating hours.
- Boiler lay-ups continue to be a problem, especially for West Coast ships. The steam blanket lay-up is good for only one month and the dry lay-up requires many man-hours of preparation.
- Boiler air casing and boiler skirt corrosion is a significant problem that affects the Ship's Force maintenance burden and the ambient temperature of the fireroom.
- B&W burners experience O-ring and return swing check valve leakage.
- Several ShipAlts associated with the fuel oil service system, such as installing vented plunger burners and Marotta FOQCVs, if accomplished during BOH, will result in an improved, safer, and more easily maintained fuel oil service system.
- Ship's Force maintenance personnel seem to encounter more problems setting safety valves that have been reworked than they normally have lifting and testing safety valves with steam after 1800 operating hours. Most repairs, such as spindle and seat replacement, can be accomplished by Ship's Force with IMA assistance, as necessary.

- Ship's Force maintenance personnel can normally perform all corrective maintenance on sootblowers.
- Some question exists as to the preferred BWLI combinations that should be installed on 1200-psi boilers. The Nucleonic RBWLIs do not have the history of reliability that the Barton RWBLIs have nor do they have an established logistic and training system like that supporting the Barton RWBLIs. It is concluded that a preferred combination of BWLIs would be one Yarway gage glass and two independent Barton RWBLIs.
- Bottom blow valves are supported by various APLs with little standardization.
- Sliding feet movement indicators are not in widespread use.

4.2 RECOMMENDATIONS

Corrective actions and improvements required for the Main Propulsion Boilers are grouped as follows:

- Baseline Overhaul (BOH) Requirements
- Intracycle Maintenance Requirements
- Follow-on ROH Requirements
- Reliability and Maintainability Improvements
- Planned Maintenance System Changes
- Industrial Facility Improvements
- IMA Improvements
- Integrated Logistic Support (ILS) Improvements

Table 4-1 summarizes all recommendations resulting from this Review of Experience. A detailed listing of recommended PMS changes is included in the DDEOC MRC Evaluation Table of Appendix E. Action items resulting from these recommendations are listed in the DDEOC Action Table of Appendix F.

Table 4-1. SUMMARY OF ROE RECOMMENDATIONS

Enrlipment	Recommendation
Baseline Overhaul Requirements	
A. REPAIRS AND OVERHAUL	
Refractory	Renew all castable refractory. Rebrick boiler as necessary based on boiler inspection report.
Special Boiler Tools	Conduct an inventory of all special tools to ensure that the on board allowances are in accordance with the manufacturer's boiler technical manuals.
Boiler Skirts	Renew boiler skirts
Safety Valves	*Remove and inspect. Repair as necessary* based on inspection, CSMP, and POT&I.
Sootblowers	Remove all sootblowers. NDT, inspect, preserve, and reinstall. Those elements which fail NDT or require repairs as determined by inspection, POT&I, and CSMP, should be repaired or replaced. Replace soot blower *piping as necessary as determined by NDT, POT&I, and CSMP.*
Valves	Overhaul all main boiler stops and main steam valves that exhibit problems such as seal ring leakage or steam leakage past the seat. Provide Ship's Force with a suitable valve reseating tool and instruction in its use.
Boiler Sliding Feet	Install a sliding foot movement indicator as shown in Figure 9-2 of NAVSHIPS 0951-LP-031-8010.
B. SHIPALTS	
Refractory	Accomplish ShipAlt DDG-37-1112D, Install Shock Hardened Brickwork.
Feedwater Quality Improvement	Accomplish the following ShipAlts: . DDG-37-1207K, Install Ion Exchanger in Feedwater Line . DDG-37-1056K, Install Morpholine Injection System . DDG-37-1175K, *Install* Dissolved Oxygen Analyzer
Air Casings	Accomplish ShipAlt DDG-37-0357K, Boiler Outer Casing Replacement, on the FW boiler equipped ships.
Economizers	Accomplish ShipAlt DDG-37-1030K, Economizer Modifications, on the FW boiler equipped ships.
Burners	Accomplish ShipAlt DDG-37-1069K, Vented Plunger Burner Installation. Accomplish the following fuel oil related ShipAlts . DDG-37-0316D, inspect and modify fuel oil burner leads . DDG-37-0361D, modify boiler front . DDG-37-1085K, Install Marotta FOXXVs
Periscopes	Accomplish ShipAlt DDG-37-1062K, install electronic and intermediate *smoke indicator.*
Boiler Water Level Indicators (BWLIs)	Accomplish the following ShipAlts: . DDG-37-1058K, Install Yarway Gage Glasses . DDG-37-1132K, Install Barton remote BWLIs (RBWLIs) Install an additional Barton RWBLI as a back-up or tertiary BWLI.
Bottom Blow System	Accomplish ShipAlt DDG-37-1229K, *Installation of* Monel Bottom Blow System. Replace all boiler blow valves.
Superheater Outlet Thermometers	Accomplish ShipAlt DDG-37-1157K, which provides a more reliable means of measuring superheater outlet temperature.
Intracycle Maintenance Requirements	
Main Propulsion Boilers	Accomplish existing PMS requirements as modified by recommendations of this report.
Follow-On ROH Requirements	
Refractory	Renew all castable refractory.
Special Boiler Tools	Conduct an inventory of all special tools to insure that the on-board allowances are in accordance with the manufacturer's boiler technical manuals.
Boiler Skirts	Inspect and repair as necessary.
Safety Valves	Remove and inspect. Repair as necessary based on inspection, CSMP, and POT&I.

(continued)

Table 4-1. (continued)

Equipment	Recommendation
Follow-On ROH Requirements (continued)	
Soothblowers	Remove all soothblowers. NDT, inspect, preserve, and reinstall. Those elements which fail NDT or require repairs as determined by inspection, POT&I, and CSMP, should be repaired as replaced. Replace soothblower piping as necessary as determined by NDT, POT&I, and CSMP.
Bottom Blow Valves	Conduct repairs as necessary.
Valves	Overhaul all main boiler stops and main steam valves that exhibit problems such as seal ring leakage or steam leakage past the seat.
Reliability and Maintainability Improvements	
Watersides	Waterjet clean all watersides 1-3 months after ROH. Conduct boiler inspection by certified boiler inspector and based on results of inspection, make a determination as to whether or not the waterside cleaning interval should be extended.
Lay-Ups	Identify the equipment and procedures necessary for implementation of a forced hot-air lay-up capability for the Fleet. Continue the use of hydrazine lay-ups at the depot level. Investigate a combination of hydrazine lay-up and forced hot-air fireside lay-up for ships whose status requires that their boilers be layed up for periods up to 6 months.
B&W Burners	Replace the slotted bushing inserts on the atomizer assemblies with an insert without slots and a rounded end.
Safety Valves	Provide Ship's Force with the new improved safety gags. Change the applicable APLs to reflect the change in gag designs and include instructions for the use of the gag in the boiler technical manual.
Yarway Gage Glasses	Provide Ship's Force with the appropriate special tools required for Yarway gage glass maintenance.
Boiler Sliding Feet	Provide a telltale for the sliding feet that would provide a positive indication of grease flow through the sliding foot. The telltale should be visible from a position near the zerk fitting in order to provide the maintenance man with positive feedback of grease flow. Investigate the use of a non-lubricated sliding foot.
Planned Maintenance System Changes	
Boiler (MIPs F-1/10, F-1/11, and F-1/196)	Change the MRC number F-1 A-2 as follows: . After step 1.b (remove pipe plug from test connection) add the following: WARNING: Do not allow live steam to pressurize the test gauge. This could result in rupturing the gauge and possible personnel injury. . Change step 1.c to read: Prepare a test pressure gauge with a 0 to 600 psi range and 1/8" fittings, by bending the hose to the gauge into a loop and charging the loop with water. Install the test gauge in the test connection. Add the following to the Tools, Parts, Materials, and Test Equipment List of MRC number F-1 R-1: . Light bulb, rough service, NSN 9C 6240-00-141-3087.
Industrial Facility Improvements	
	None
IMA Improvements	
	None
Integrated Logistic Support (ILS) Improvements	
Yarway Gage Glasses	Increase each ship's allowance to include two complete gage glasses (one per fireroom) to be carried as bulkhead mounted spares.
Bottom Blow Valves	Provide Ship's Force with a minimum of six operating space spares of bottom blow valve, NSN, 9C 4820-01-018-1781.
Boiler Stop Valves	Establish a procedure to insure that changes in the internal dimensions of boiler stop valves are documented and appropriate APL and allowance changes are made.
Boiler Water Level Indicators (BWLIs)	Cancel ShipAlt DDG-47-1070K, install nucleonic BWLIs.

SOURCES OF INFORMATION

The specific sources of information used as a basis for the System Maintenance Analysis of the DDG-37 Class Main Propulsion Boilers are listed below:

1. Generation IV MDS Part and Maintenance Data for DDG-37 Class for the period 1 January 1970 through 30 September 1977.

2. CASREP narrative summaries for the period 1 July 1973 to 30 September 1977.

3. Technical Manuals:

   - NAVSHIPS 351-061D, Babcock and Wilcox Main Boilers.
   - NAVSHIPS 0351-061-5000 (Volume I of II) and NAVSHIPS 0351-061-5010 (Volume II of II), Foster Wheeler, 1200 PSI Main Boilers.
   - NAVSEA 0901-LP-220-0010, NSTM Chapter 220, Volume I, Boiler Water/ Feedwater Water Chemistry.
   - NAVSEA 0901-LP-220-0020, NSTM Chapter 220, Volume 2, Boiler Water/ Feedwater Test and Treatment.
   - NAVSEA 59086-GY-STM-000, NSTM Chapter 221, Boilers.

4. Ship Information Book DLG-9 (DDG-40):

   - Volume I, Hull and Mechanical, NAVSHIPS 0905-475-4010.
   - Volume 2, Part 1 of 2, Piping, NAVSHIPS 0905-475-4020.
   - Volume 2, Part 2 of 2, Piping, NAVSHIPS 0905-475-4030.

5. Propulsion Operating Guides for DDG-36, -37, -38, -42 and -45.

6. Type Commander's COSAL, SURFLANT and SURFPAC, dated 28 April 1976 and 23 June 1976, respectively.

7. Allowance Parts Lists for selected components of the DDG-37 Class Main Propulsion Boilers and Ancilliary Equipment.

8. Maintenance Index Pages and Maintenance Requirement Cards for selected components of the DDG-37 Class Main Propulsion Boilers and Ancillary Equipment.

9. Trip Report (13-15 March 1978); ARINC Research Corporation Visit to:

   - USS MAHAN (DDG-42)
   - USS PRATT (DDG-44)

10. PERA (CRUDES), PHILNAVSHIPYD, *Ship Alteration Information Manual, DDG-37 Class*, 1 November 1976.

11. COMNAVSURFLANT, Alteration Management System, Alteration Status Matrix for DDG-37 Class, dated 22 February 1978.

12. Steam Propulsion Plant Improvement Program (PMS-301), ShipAlt Program (1200-PSI Ships).

13. Steam Propulsion Plant Improvement Program (PSM-301), OPN Background (1200-PSI Ships).

14. NAVSEA 0900-079-4020, Ship Alteration Management Information System, Information Manual.

15. *System Maintenance Analysis, FF-1052 Class Propulsion Boiler System*, ARINC Research Publication 1646-03-6-1589, March 1977.

16. OPNAVINST 4790.4, *Material Maintenance Management (3M) Manual*, Volumes I and II, June 1973.

17. *DDG-37 Class Maintenance Critical Equipment List*, ARINC Research Corporation, 30 April 1976.

18. SARPs and Overhaul Departure Reports for DDG-37 Class Ships.

19. Repair Profile for Baseline Overhaul of DDG-37 Class, May 1977.

20. Interim, DDG-37 Class, DDEOC, Engineered Maintenance Planning Forms and Qualified Maintenance Planning Forms.

21. NAVSEA (PMS-301) Steam Propulsion Plant Improvement Program Advisories.

22. CNO 1200 PSI Propulsion Plant Overhaul Policy for FY 1975.

23. OP-04 Memorandum for the Vice Chief of Naval Operations, OP-04 P/MN, Ser 04P/6699, dated 27 November 1974, Subject: Standards for Overhauling 1200 PSI Propulsion Plant.

24. NAVSHIPSYSCOMHQ Washington, D.C., 151357Z May 73, Standards for Overhaul of 1200 PSI Main Propulsion Plants; Mandatory Overhaul Requirements for USS FARRAGUT Pilot Program.

APPENDIX A

BOUNDARIES OF THE MAIN PROPULSION BOILER SYSTEM FOR DDG-37 CLASS SHIPS

The Main Propulsion Boiler Systems discussed in this report consist principally of the components listed in Table A-1. The table also lists APL numbers and APL quantities per ship. In developing this table, an attempt was made to resolve inconsistencies among Type Commander's COSAL and MDS reporting data, but all such inconsistencies could not be resolved. This configuration is the best estimate from all available data sources.

Figures A-1 and A-2 are graphic representations of a typical Babcock and Wilcox (B&W) boiler and ancillary equipment and a comparable Foster Wheeler (FW) boiler for a DDG-37 Class ship. The APLs supporting the various components are provided. The bottom blow valve APLs that are listed were those that were reported in MDS data and are an indication of the various APLs included in the bottom blow system.

Table A-1. COMPONENTS OF THE MAIN PROPULSION BOILER SYSTEMS FOR DDG-37 CLASS SHIPS

Nomenclature	APL/CID	Quantity by Hull Number									
		DDG-37	DDG-38	DDG-39	DDG-40	DDG-41	DDG-42	DDG-43	DDG-44	DDG-45	DDG-46
B&W Boilers and Associated Equipment											
Main Steam Boiler (B&W)	021200163*				4	4	4	4	4	4	4
Burners	300020102*				24	24	24	24	24	24	24
Periscope	382010002*				4	4	4	4	4	4	4
Pilot Safety Valve	882170237*				4	4	4	4	4	4	
Pilot Safety Valve	882170240*										4
Drum Safety Valve	882170239*				8	8	8	8	8	8	8
Superheater Safety Valve	882170241*				4	4	4	4	4	4	4
Sootblower Head	813020075*				8	8	8	8	8	8	8
Sootblower Head	813020074*				16	16	16	16	16	16	16
FW Boilers and Associated Equipment											
Main Steam Boiler (FW)	021550074**	4	4	4							
Burner	300080084**	16	16	16							
Periscope	382030001**	4	4	4							
Pilot Safety Valve	882170298**	4	4	4							
Drum Safety Valve	882170247**	8	8	8							
Superheater Safety Valve	882170248**	4	4	4							
Sootblower Head	813030028**	36	36	36							
Equipment Not Specifically Associated with a Particular Boiler Manufacturer											
Main Boiler Stop Valve	882000847	4	4	4						4	4
Main Boiler Stop Valve	882000869				4	4	4	4	4		
Jerguson Gage Glass	450020083**	Precise Configuration Not Available									
Yarway Gage Glass	450030034**										
Bottom Blow Valve	882000523										
Bottom Blow Valve	882002390										

*NAVSHIPS Technical Manual 0351-061-5010(Vol. I of II) & 0351-061-5010(Vol. II of II)

**NAVSHIPS Technical Manual 0351-061-5000(Vol. I of II) & 0351-061-5010(Vol. II of II)

(continued)

Table A-1. (continued)

Nomenclature	APL/CID	Quantity by Hull Number									
		DDG-37	DDG-38	DDG-39	DDG-40	DDG-41	DDG-42	DDG-43	DDG-44	DDG-45	DDG-46
Equipment Not Specifically Associated with a Particular Boiler Manufacturer (cont.)											
2.5" IPS 1500 psi Gate Valve	882047601										
6.0" IPS 1500 psi Gate Valve	882040806										
3.0" IPS 600 psi Gate Valve	882040810										
2.5" IPS 1500 psi Gate Valve	882041652	Precise Configuration Not Available									
6.0" IPS 1500 psi Gate Valve	882041650										
3.0" IPS 1500 psi Gate Valve	882040694										
Tube Punching Gear	418020002										

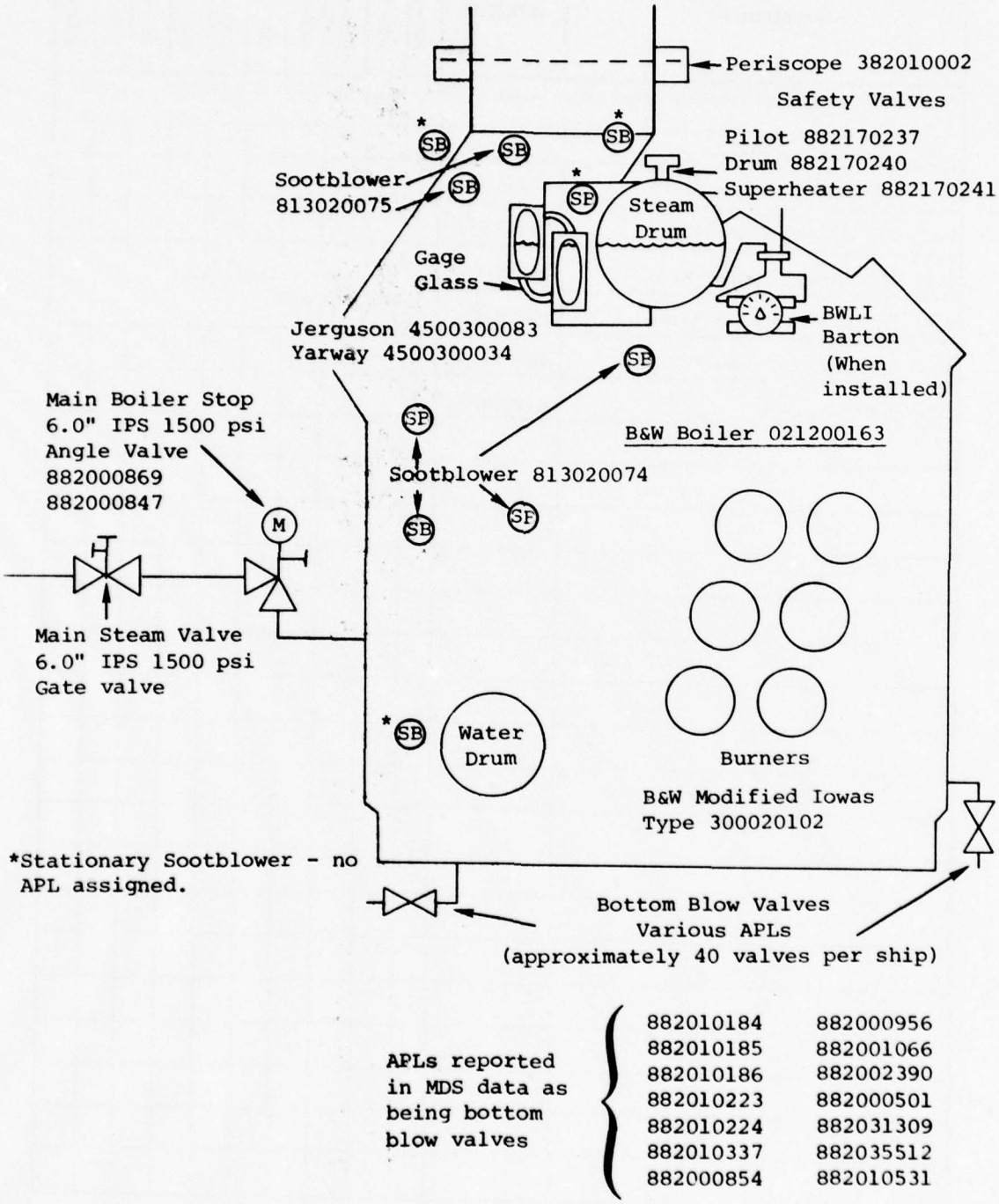
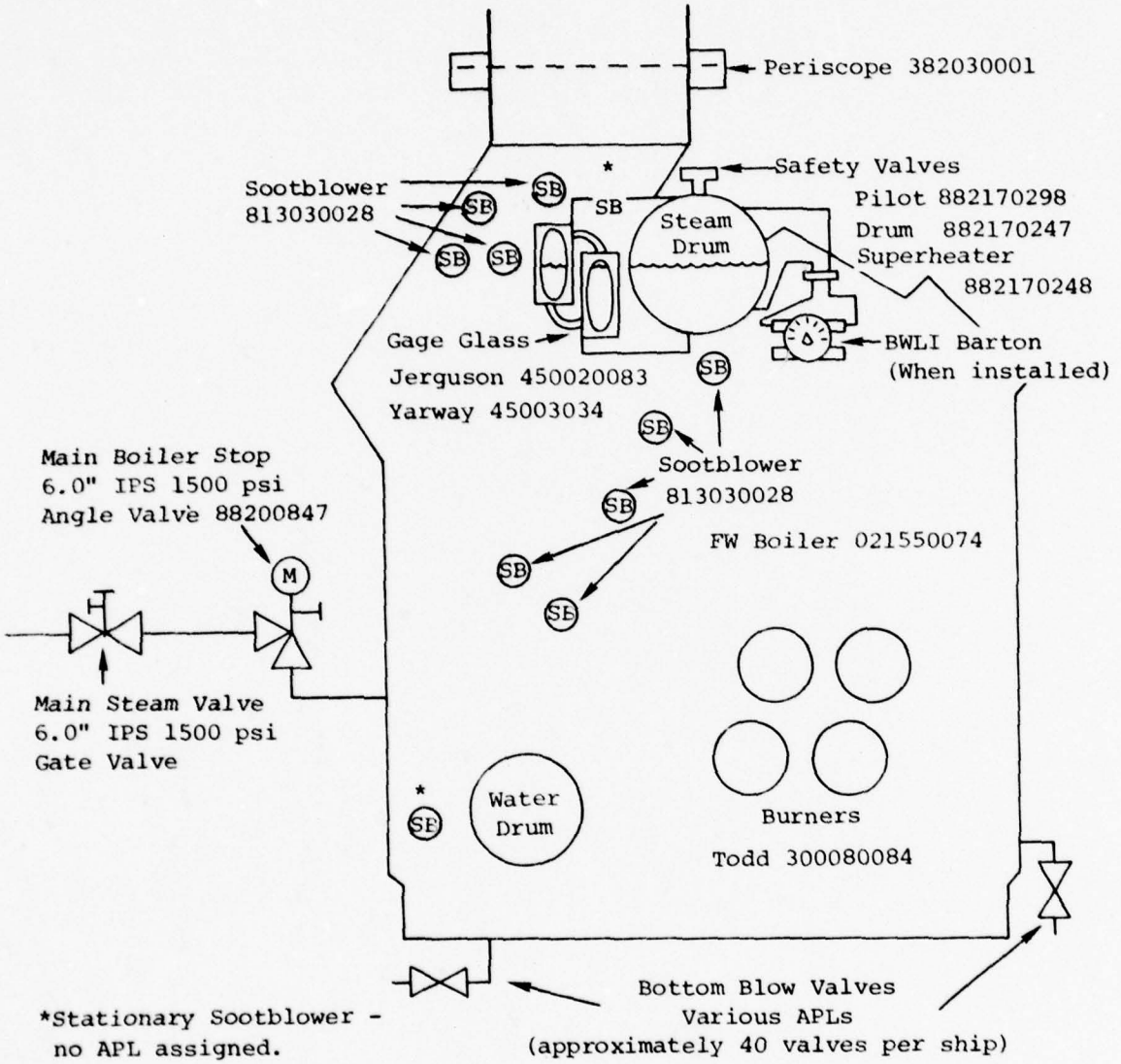


Figure A-1. TYPICAL DDG-37 CLASS B&W BOILER WITH ANCILLARY EQUIPMENT



APLs reported in MDS data as being buttom blow valves

882000854	882051970
882001049	882054128
882001050	882054261
882000523	882010541
882000956	882010564
882003446	882010565
882031309	

Figure A-2. TYPICAL DDG-37 CLASS FW BOILER WITH ANCILLARY EQUIPMENT

APPENDIX B

CASREP SUMMARY

CASREPs for the DDG-37 Class Main Propulsion Boilers covering the period from 1 July 1973 to 30 September 1977 are shown in Table B-1. The numbers of CASREPs are listed by equipments and categorized by failure mode. The table is based on 237 CASREPs submitted by 10 ships that operated for a total of 31.5 ship operating years during the CASREP data period. Therefore, the rate of CASREP submission against the Main Propulsion Boilers for this period is:

$$\frac{237 \text{ CASREPS}}{31.5 \text{ Ship Operating Years}} = 7.52 \text{ CASREPs per Ship Operating Year}$$

Table B-1. CASREP ANALYSIS SUMMARY FOR DDG-37 CLASS MAIN PROPULSION BOILERS

Equipment and Reason for CASREP (Failure Mode)	Number of Casualty Reports		Percent of Total	Number Of Ships Reported
	By Failure Mode	By Equipment		
Boilers		86	36.3	10
Cracks in Steam or Water Drum	1			1
Ruptured Tubes	7			4
Leaking or Blistered Tubes	8			3
Desuperheater Leaks	2			2
Weld Leaks in Assoc. Piping	3			3
Economizer Leaks	14			6
Leaky HH Plates on Headers	3			2
Leaky HH Plates on SH Headers	5			5
Ruptured SH Tubes	9			6
Boiler Air Casing Leaks	9			5
Missing Gaskets	1			1
Leaking or Blistered SH Tubes	1			1
Misc (Piping, Sliding Feet, etc)	20			9
Cracking SH Hdr.	3			1
Valves		70	29.5	10
Safety Valves and Escape Piping	21			7
Seal Ring Leaks	6			3
Gasket & Flange Leaks	5			3
Main Steam Steps & Bypasses	9			4
FO Control Valves	5			3
BB/Surface Flow Valves	24			7
Bottom Blow Piping		17	7.2	7
Soot Blowers & Piping		3	1.3	3
ACC & 3-Element Feed System		18	7.6	5
Thermometers		3	1.3	1
BWLIs		6	2.5	3
Personnel Error/Operating Casualties		6	2.5	5
No Failure		7	3.0	5
Drain Lines		8	3.4	6
Improper Lay-ups		7	3.0	2
Sample Coolers		1	0.4	1
Lack of Trained Personnel		4	1.7	1
12/6 Reducing Valves		1	0.4	1
Totals	156	237	100.1	-

APPENDIX C

DDG-37 CLASS MAIN PROPULSION BOILER SHIPALT SUMMARY

The ShipAlts listed in Table C-1 are recommended for accomplishment during BOH. They are identified by ShipAlt number, brief, applicable section in this report, and status by hull number.

Table C-1. DDG-37 CLASS MAIN PROPULSION BOILER SHIPALT SUMMARY

Ship-Alt No. DDG-37	Brief	Applicable Section in ROE	Hull Number									
			DDG-37	DDG-38	DDG-39	DDG-40	DDG-41	DDG-42	DDG-43	DDG-44	DDG-45	DDG-46
1112D	Shock Hardened Brickwork	3.2.2.1	A	A	C	A	A	A	A	A	A	C
1207 K	Ion Exchanger in Feedwater	3.2.2.2	C	C	A	C	A	A	A	A	A	A
1056 K	Morpholine Injection System	3.2.2.2	C	C	A	C	C	C	A	A	C	C
1175 K	Dissolved Oxygen Analyzer	3.2.2.2	A	A	A	A	A	A	A	A	A	A
0357 K	Boiler Outer Casing Replacement	3.2.4	A	A	A	N	N	N	N	N	N	N
1030 K	Economizer Modifications	3.4.2	A	A	A	N	N	N	N	N	N	N
1069 K	VP Atomizer Burners	3.3.3	C	C	A	C	A	A	A	A	A	A
0361 F	Inspect/Modify Burner Leads	3.3.3	A	A	A	C	A	A	C	A	A	A
0316 D	Modify Boiler Front	3.3.3	A	A	A	A	A	A	C	A	A	A
1085 K	Marotta FOQCVS	3.3.3	A	A	A	C	A	A	A	A	A	A
1062 K	Improved Smoke Indicator	3.3.4	C	A	A	A	C	C	A	A	C	C
1058 K	Yarway Gage Glasses	3.5.1	C	C	A	C	C	C	A	A	C	C
1132 K	Install Barton BWLI	3.5.2	A	C	A	C	A	A	A	A	A	A
1079 K	Nucleonic BWLI	3.5.2	A	A	A	A	A	A	A	A	A	A
1229 K	Monel Bottom Blow Piping	3.6.2	A	C	A	C	A	A	A	A	A	A
1057 K	Improved Superheater Thermometers	3.10.3	C	C	A	C	C	C	A	A	A	C

Alteration Completion Status:

A - Outstanding, has not been accomplished, but is applicable to that particular ship.

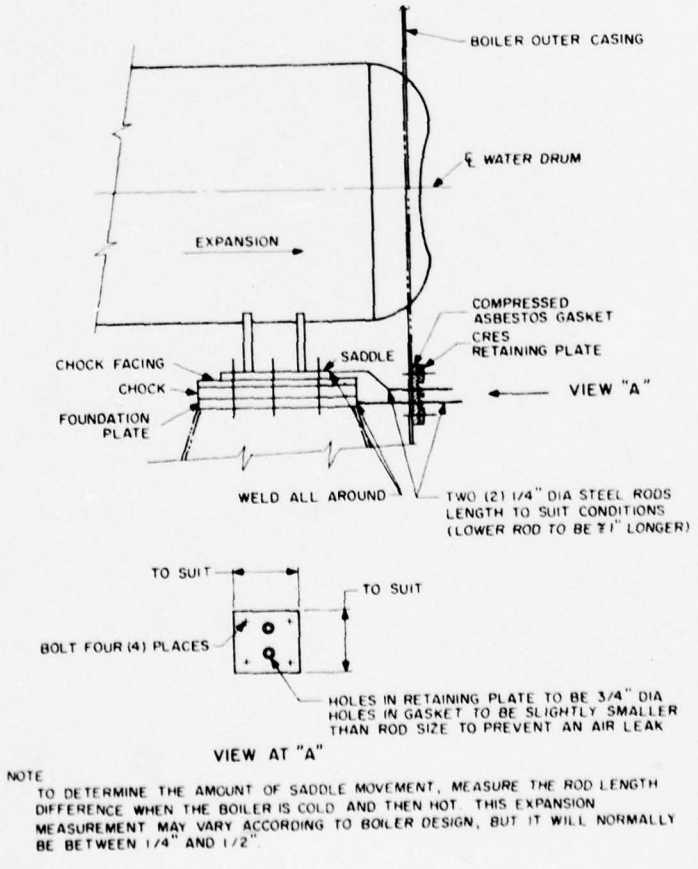
C - Completed, has been accomplished on that particular ship.

N - Not applicable

APPENDIX D

SLIDING SADDLE MOVEMENT INDICATOR

Figure D-1 is a reproduction of Figure 9-2 found in Chapter 9 of NAVSEA 0951-LP-031-8010, Repair and Overhaul, Main Boiler, 1200 psi Steam Propulsion Plant. This indicator will provide a positive indication of sliding foot movement.



NOTE
TO DETERMINE THE AMOUNT OF SADDLE MOVEMENT, MEASURE THE ROD LENGTH DIFFERENCE WHEN THE BOILER IS COLD AND THEN HOT. THIS EXPANSION MEASUREMENT MAY VARY ACCORDING TO BOILER DESIGN, BUT IT WILL NORMALLY BE BETWEEN 1/4" AND 1/2".

Figure D-1. SLIDING SADDLE MOVEMENT INDICATOR

APPENDIX E

MRC EVALUATION

The DDEOC MRC Evaluation form in this appendix specifies the Maintenance Index Pages applicable to the Main Propulsion Boilers and lists the Maintenance Requirements Cards that should be modified or deleted, and indicates where new MRCs are needed:

- MRC Title - Description of maintenance specified by MRC
- MRC Number - Identification number of MRC
- Responsibility - Organizations responsible for change (if any)
- Current Status (self-explanatory)
- Man-Hours - Personnel time burden allotted to complete maintenance action
- Frequency - When the MRC maintenance action is to be performed, e.g., D = daily, W = weekly, M = monthly, Q = quarterly, S = semiannually, A = annually, C = once every cycle, R = as required
- Type - Perform maintenance (P), or survey material condition of components (S)
- Who Performs Test - Maintenance action or test to be performed by tender, or DDEOC site team, or Ship's Force personnel
- Where performed (self-explanatory)
- Data - Indicates whether data are recorded during performance of maintenance action

MRC TITLE	MRC NUMBER	RESPONSIBILITY		CURRENT STATUS			MAN-HOURS		FRE
		NAVSEA	DDEOC	OLD WITH NO CHANGE	OLD WITH REVISION	NEW	PRE-DDEOC M/H	POST-DDEOC M/H	PRE-DDEO
BOILER (various MIPs including F-1/10, F-1/33, and F-1/196)									
1. Test soot blower operating pressure	F-1 A-2	X			X		2.0	2.0	A
2. Clean and inspect firesides	F-1 R-1	X			X		220.0	220.0	R

*P = PERFORM MAINTENANCE; S = SURVEY INSPECTION

SHIP CLASS: DDG-37

SMA NO: 37-108-221

SYSTEM: Main Propulsion Boilers

MRC EVALUATION

HOURS	FREQUENCY		TYPE*	WHO PERFORMS TEST			WHERE PERFORMED	DATA	REMARKS
POST-DDEOC M/H	PRE-DDEOC	POST-DDEOC	P-PERF. S-SURV.	TENDER	DDEOC	SHIP	I-IN PORT S-AT SEA	YES NO	
2.0	A	A	P,S			X	I,S	Yes	A potentially hazardous condition exists during the accomplishment of this PMS check. Live steam entering the test gauge could cause a rupture and injure the personnel conducting the check. Change MRC F-1 A-2 as follows: . After step 1b (remove pipe plug from test connection) add the following: WARNING: Do not allow live steam to pressurize the test gauge. This could result in rupturing the gauge and possible personnel injury. . Change step 1.c to read: Prepare a test pressure gauge, with a 0 to 60 psi range and 3/8" fittings, by bending the hose to the gauge into a loop and charging the loop with water. Install the test gauge in the test connection.
220.0	R	R	P			X	I,S	No	Add the following to Tools, Parts, Materials Test Equipment List: Light bulb, rough service, NSN 9G 6240-00-143-3087.

2

APPENDIX F

DDEOC ACTION TABLE

DDEOC action items are presented in the table of this appendix. The table is formatted to provide the implementation status of changes through completion of the Class Maintenance Plan and to serve as a ready reference to specific sections in Chapter Three that address in detail the problem involved.

DDEOC ACTION TABLE

1. ACTION ITEM * a. NO.	1. ACTION ITEM * b. TITLE	2. DDEOC EVALUATION **	3. ACTION ITEM DESCRIPTION	4. REPORT REFERENCE (PARA.)	5. RESPONSIBILITY †
1.	BASELINE OVERHAUL REQUIREMENTS				
	A. Repairs and Overhaul				
	Boiler Strength Test		Prepare boiler for and conduct 150% strength test in accordance with NSTM Chapter 221.	Table 3.5	NAVSEA 934X
	Refractory		Renew all castable refractory.	3.2.1.1	NAVSEA 934X
			Rebrick boiler as necessary based on boiler inspection report.	3.2.1.1	NAVSEA 934X
	Special Boiler Tools		Conduct an inventory of all special tools to insure that the on board allowances are in accordance with the manufacturers boiler technical manuals.	3.2.2.2	NAVSEA 934X
	Boiler Skirts		Renew boiler skirts.	3.2.4.1	NAVSEA 934X
	Safety Valves		Remove and inspect. Repair as necessary based on inspection, CSMP, and POT&I.	3.3.5 & 3.4.5	NAVSEA 934X
	Sootblowers		Remove all sootblowers. NDT, inspect, preserve, and reinstall. Those elements which fail NDT or require repairs as determined by inspection, POT&I, and CSMP should be repaired or replaced. Replace sootblower piping as necessary as determined by NDT, POT&I, and CSMP.	3.3.6 & 3.4.6	NAVSEA 934X
	Valves		Overhaul all main boiler stops and main steam valves that exhibit problems such as seal ring leakage or steam leakage past the seat.	3.7.2 & 3.8.2	NAVSEA 934X
			Provide Ship's Force with a suitable valve reseating tool and instruction in its use.	3.8.2	NAVSEA 934X
	Boiler Sliding Feet		Install a sliding foot movement indicator as shown in Figure 9-2 of NAVSHIPS 0951-LP-031-8010. Repair and overhaul Main Boilers, 1200 psi Steam Propulsion Plant.	3.9.2 &	NAVSEA 934X

* NOTE 1: DEVELOPING ACTIVITY FILL IN THE FOLLOWING BLOCKS: 1a, b; 3; 4; 5 (IF KNOWN); 6a, IF REQUIRED FOR CONTINUATION OF DEVEL
** NOTE 2: DDEOC EVALUATION – APPROVED, FURTHER STUDY REQ'D, ETC.
† NOTE 3: RESPONSIBILITY – ACTIVITY RESPONSIBLE FOR TAKING THE ACTION.

SHIP CLASS: DDG-37

SMA NO: 37-108-221

SYSTEM: Main Propulsion Boilers

ACTION TABLE

REPORT REFERENCE (PARA.)	5. RESPONSIBILITY †	6. SCHEDULING DATES a. REQD.	b. START	c. COMP.	7. REMARKS, FUNDING IMPLICATIONS, ETC.	8. ACTUAL ACTION TAKEN
Table 3.5	NAVSEA 934X					
3.2.1.1	NAVSEA 934X					
3.2.1.1	NAVSEA 934X				Accomplish only if ShipAlt DDG-37-112D has been accomplished.	
3.2.2.2	NAVSEA 934X				NAVSHIPS 351-0610, Babcock & Wilcox, Main Boiler Technical Manual, Chapter 4, Section 2. NAVSHIPS 0351-061-5000, Foster Wheeler, 1200 psi Main Boiler, Section S.	
3.2.4.1	NAVSEA 934X					
3.3.5 & 3.4.5	NAVSEA 934X					
3.3.6 & 3.4.6	NAVSEA 934X					
3.7.2 & 3.8.2	NAVSEA 934X					
3.8.2	NAVSEA 934X					
3.9.2 &	NAVSEA 934X					

† CONTINUATION OF DEVELOPING ACTIVITY TASK; 7, AS NECESSARY.

DDEOC ACTION TABLE

1 ACTION ITEM * a. NO.	b. TITLE	2 DDEOC EVALUATION **	3 ACTION ITEM DESCRIPTION	4 REPORT REFERENCE (PARA.)	5 RESPONSIBILITY †
	B. ShipAlts				
	Refractory		Accomplish ShipAlt DDG-37-1112D, install Shock Hardened Brickwork.	3.2.1.1	NAVSEA 93
	Feedwater Quality Improvement		Accomplish the following ShipAlts: . DDG-37-1027K, Install Ion Exchanger in Feed Line. . DDG-37-1056K, Install Morpholine Injection System. . DDG-37-1157K, Install Dissolved Oxygen Indicator.	3.2.2.3	NAVSEA 93
	Air Casings		Accomplish ShipAlt DDG-37-0357K, Boiler Outer Air Casing Replacement, on Foster-Wheeler-boiler-equipped ships.	3.2.4.1	NAVSEA 9
	Economizer	Modification	Accomplish ShipAlt DDG-37-1030K, Economizer, on the FW-boiler-equipped ships.	3.4.1	NAVSEA 93
	Burners		Accomplish ShipAlt DDG-37-1069K, Install Vented Plunger Burners.	3.3.3 & 3.4.3	NAVSEA 9
			Accomplish the following fuel-oil-related ShipAlts: . DDG-37-0316D, Inspect and Modify Fuel Oil Burner Leads. . DDG-37-0361D, Modify Boiler Front. . DDG-37-1085K, Install Marotta FOQCVs.	3.3.3	NAVSEA 9
	Periscopes		Accomplish ShipAlt DDG-37-1062K, Install Electronic and Intermediate Smoke Indicator.		NAVSEA 9
	Boiler Water Level Indicators (BWLIs)		Accomplish the following ShipAlts: . DDG-37-1058K, Install Yarway Gage Glasses. . DDG-37-1132K, Install Barton Remote BWLIs (RBWLIs)	3.5.2	NAVSEA 9

* NOTE 1: DEVELOPING ACTIVITY FILL IN THE FOLLOWING BLOCKS: 1a, b; 3; 4; 5 (IF KNOWN); 6a, IF REQUIRED FOR CONTINUATION OF DE

** NOTE 2: DDEOC EVALUATION – APPROVED, FURTHER STUDY REQ'D, ETC.

† NOTE 3: RESPONSIBILITY – ACTIVITY RESPONSIBLE FOR TAKING THE ACTION.

1

SHIP CLASS: DDG-37

SMA NO: 37-108-221

SYSTEM: Main Propulsion Boilers

DDEOC ACTION TABLE

	4 REPORT REFERENCE (PARA.)	5 RESPONSIBILITY †	6 SCHEDULING DATES a REQD.	b START	c COMP.	7 REMARKS, FUNDING IMPLICATIONS, ETC.	8 ACTUAL ACTION TAKEN
stall	3.2.1.1	NAVSEA 934X					
	3.2.2.3	NAVSEA 934X					
ger							
iler ter-	3.2.4.1	NAVSEA 934X					
ono- ips.	3.4.1	NAVSEA 934X					
stall	3.3.3 & 3.4.3	NAVSEA 934X					
related	3.3.3	NAVSEA 934X					
t.							
QCVs.							
stall ndi-		NAVSEA 934X					
	3.5.2	NAVSEA 934X					
e							
ote							

QUIRED FOR CONTINUATION OF DEVELOPING ACTIVITY TASK; 7, AS NECESSARY.

DDEOC ACTION TABLE

ACTION ITEM* NO	ACTION ITEM* TITLE	DDEOC EVALUATION**	ACTION ITEM DESCRIPTION	REPORT REFERENCE (PARA.)	RESPONSIBILITY†
	Boiler Water Level Indicators (BWLIs) (Continued)				
			Install an additional Barton RBWLI as a back-up or tertiary BWLI. Installation should be in accordance with ShipAlt DDG-37-1132K.	3.5.2	NAVSEA 934X
	Bottom Blow System		Accomplish ShipAlt DDG-37-1229K, Installation of Monel Bottom Blow System.	3.6.2	NAVSEA 934X
	Superheater Outlet Thermometer		Accomplish ShipAlt DDG-37-1057K, which provides a more reliable means of measuring superheater outlet temperature.	3.10.2	NAVSEA 934X
2.	INTRACYCLE MAINTENANCE REQUIREMENTS				
			No additional action required.		
3.	FOLLOW-ON ROH REQUIREMENTS				
	Refractory		Renew all castable refractory.	3.2.1.1	NAVSEA 934X
			Rebrick boiler as necessary based on boiler inspection report.	3.2.1.1	NAVSEA 934X
	Special Boiler Tools		Conduct an inventory of all special tools to insure that the on-board allowances are in accordance with the manufacturers' boiler technical manuals.	3.2.2.2	NAVSEA 934X
	Boiler Skirts		Inspect and repair as necessary.	3.2.4.1	NAVSEA 934X
	Safety Valves		Remove and inspect. Repair as necessary based on inspection, CSMP, and POT&I.	3.3.5 & 3.4.5	NAVSEA 934X
	Sootblowers		Remove all sootblowers. NDT, inspect, preserve, and reinstall. Those elements which fail NDT or require repairs as determined by inspection, POT&I, and CSMP, should be repaired or replaced. Replace sootblower piping as necessary as determined by NDT, POT&I, and CSMP.	3.3.6 & 3.4.6	NAVSEA 934X
	Valves		Overhaul all main boiler stops and main steam valves that exhibit problems such as seal ring leakage or steam leakage past the seat.	3.7.2 & 3.8.2	NAVSEA 934X

* NOTE 1: DEVELOPING ACTIVITY FILL IN THE FOLLOWING BLOCKS: 1a, b; 3; 4; 5 (IF KNOWN); 6a, IF REQUIRED FOR CONTINUATION OF DEVE

** NOTE 2: DDEOC EVALUATION – APPROVED, FURTHER STUDY REQ'D, ETC.

† NOTE 3: RESPONSIBILITY – ACTIVITY RESPONSIBLE FOR TAKING THE ACTION.

SHIP CLASS: DDG-37

SMA NO: 37-108-221

SYSTEM: Main Propulsion Boilers

DEOC ACTION TABLE

	4 REPORT REFERENCE (PARA.)	5 RESPONSIBILITY †	6 SCHEDULING DATES a REQD.	b START	c COMP.	7 REMARKS, FUNDING IMPLICATIONS, ETC.	8 ACTUAL ACTION TAKEN
a	3.5.2	NAVSEA 934X					
l-	3.6.2	NAVSEA 934X					
	3.10.2	NAVSEA 934X					
	3.2.1.1	NAVSEA 934X					
	3.2.1.1	NAVSEA 934X					
ols rs'	3.2.2.2	NAVSEA 934X				NAVSHIPS 351-0610, Babcock & Wilcox, Main Boiler Technical Manual, Chap. 4, Section 2. NAVSHIPS 0351-061-5000, Foster Wheeler, 1200 psi Main Boiler, Section S.	
	3.2.4.1	NAVSEA 934X					
y	3.3.5 & 3.4.5	NAVSEA 934X					
s	3.3.6 & 3.4.6	NAVSEA 934X					
n h	3.7.2 & 3.8.2	NAVSEA 934X					

ED FOR CONTINUATION OF DEVELOPING ACTIVITY TASK; 7, AS NECESSARY.

1. ACTION ITEM * a. NO.	1. ACTION ITEM * b. TITLE	2. DDEOC EVALUATION **	3. ACTION ITEM DESCRIPTION	4. REPORT REFERENCE (PARA.)	5.
4.	RELIABILITY AND MAINTAINABILITY IMPROVEMENTS				
	Watersides		Waterjet clean all watersides 1-3 months after BOH. Conduct boiler inspection by certified boiler inspector and based on results of inspection, make a determination as to whether or not the waterside cleaning interval should be extended.	3.2.2	NA
	Lay-ups		Identify the equipment and procedures necessary for implementation of a forced hot-air lay-up capability for the fleet.	3.2.3	NA
			Continue use of the hydrazine lay-ups at the depot level. Investigate a combination of hydrazine lay-up and forced hot-air fireside lay-up for ships whose status requires that their boilers be layed up for periods up to 6 months.		
	B&W Burners		Replace the slotted bushing inserts on atomizer assemblies with an insert without slots and a rounded end.	3.3.3	NA
	Safety Valves		Provide Ship's Force with the new improved safety gags. Change the applicable APLs to reflect the change in gag design and include instructions for the use of the gag in the boiler technical manual.	3.3.5 & 3.4.5	NA
	Yarway Gage Glasses		Provide Ship's Force with the appropriate special tools required for Yarway gage glass maintenance.	3.5.2	NA
	Boiler Sliding Feet		Provide a telltale for the sliding feet that would provide a positive indication of grease flow through the sliding foot. The telltale should be visible from a position near the zerk fitting in order to provide the maintenance man with positive feedback of grease flow.	3.9.2	NA
			Investigate the use of a non-lubricated sliding foot.	3.9.2	NA

* NOTE 1: DEVELOPING ACTIVITY FILL IN THE FOLLOWING BLOCKS: 1a, b; 3; 4; 5 (IF KNOWN); 6a, IF REQUIRED FOR CONTINUATIO

** NOTE 2: DDEOC EVALUATION – APPROVED, FURTHER STUDY REQ'D, ETC.

† NOTE 3: RESPONSIBILITY – ACTIVITY RESPONSIBLE FOR TAKING THE ACTION.

SHIP CLASS: DDG-37

SMA NO: 37-108-221

SYSTEM: Main Propulsion Boilers

DEOC ACTION TABLE

	4. REPORT REFERENCE (PARA.)	5. RESPONSIBILITY †	6. SCHEDULING DATES a. REQD.	b. START	c. COMP.	7. REMARKS, FUNDING IMPLICATIONS, ETC.	8. ACTUAL ACTION TAKEN
hs y n a- e	3.2.2	NAVSEA 934X					
ed t. at - t-	3.2.3	NAVSEA 934X					
	3.3.3	NAVSEA 934X				This is a short term fix until the VP burners are installed.	
ble gn f .	3.3.5 & 3.4.5	NAVSEA 934X					
ate	3.5.2	NAVSEA 934X					
t lon t. r si-	3.9.2	NAVSEA 934X					
d	3.9.2	NAVSEA 934X					

ED FOR CONTINUATION OF DEVELOPING ACTIVITY TASK; 7, AS NECESSARY.

1 ACTION ITEM * a. NO	b. TITLE	2 DDEOC EVALUATION **	3 ACTION ITEM DESCRIPTION	4 REPORT REFERENCE (PARA.)
5.	PLANNED MAINTENANCE SYSTEM CHANGES			
	Boiler (MIPs F-1/10, F-1/33, and F-1/96)		Change MRC number F-1 A-2 as follows: . After step 1.b (remove pipe plug from test connection). WARNING: Do not allow line steam to pressurize the test gauge. This could result in rupturing the gauge and possible personnel injury. . Change step 1.c to read: Use test gauge with a 0 to 600 psi range and 3/8" fittings. Before connecting the gauge make a loop in the gauge hose and charge the loop with water. Install the test gauge in the connection.	3.4.6
			Add the following to the Tools, Parts, Materials, and Test Equipment List of the MRC number F-1 R-1: . Light bulb, rough service, NSN 9G 6240-00-143-3087.	3.3.3 and 3.4.4
6.	INDUSTRIAL FACILITY IMPROVEMENTS		None	
7.	IMA IMPROVEMENTS		None	
8.	INTEGRATED LOGISTICS SUPPORT (ILS) IMPROVEMENTS			
	Yarway Gage Glasses		Increase each ship's allowance to include two complete gage glasses (one per fireroom) to be carried as bulkhead mounted spares.	3.5.2
	Bottom Blow Valves		Provide Ship's Force with a minimum of six operating space spares of bottom blow valve, NSN 9C 4820-01-018-3781.	3.6.2
	BWLIs		Cancel ShipAlt DDG-37-1070K, Install Nucleonic BWLIs	3.5.2

* NOTE 1: DEVELOPING ACTIVITY FILL IN THE FOLLOWING BLOCKS: 1a, b; 3; 4; 5 (IF KNOWN); 6a, IF REQUIRED FOR CONTINU

** NOTE 2: DDEOC EVALUATION – APPROVED, FURTHER STUDY REQ'D, ETC.

† NOTE 3: RESPONSIBILITY – ACTIVITY RESPONSIBLE FOR TAKING THE ACTION.

SHIP CLASS: DDG-37

SMA NO: 37-108-221

SYSTEM: Main Propulsion Boilers

OC ACTION TABLE

4 REPORT REFERENCE (PARA)	5 RESPONSIBILITY †	6 SCHEDULING DATES a REQD	b START	c COMP	7 REMARKS, FUNDING IMPLICATIONS, ETC.	8 ACTUAL ACTION TAKEN
3.4.6	NAVSEA 934X					
3.3.3 and 3.4.4	NAVSEA 934X					
3.5.2	NAVSEA 934X				NSN 1HD6680-00-866-6136	
[illegible]	NAVSEA 934X					

† CONFIRMATION OF DEVELOPING ACTIVITY TASK 7, AS NECESSARY.

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